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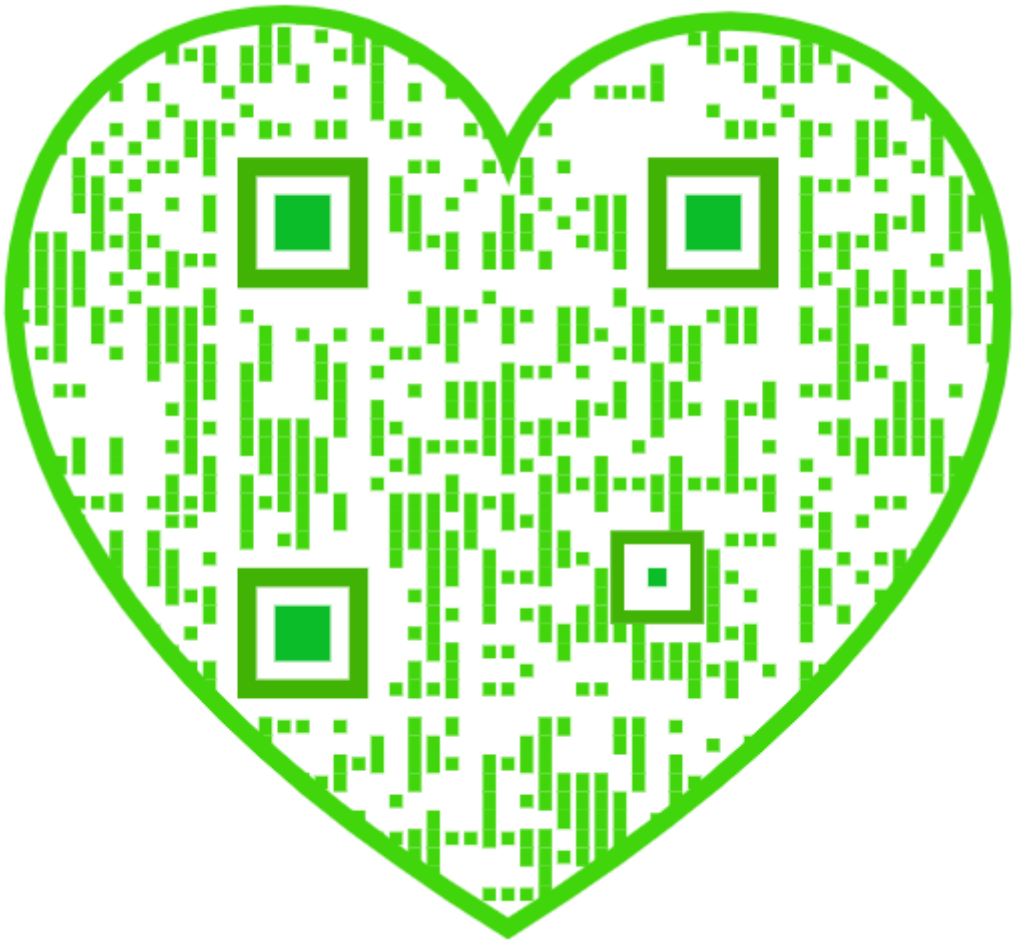

Water and Sewage Works

MUNICIPAL ENGINEERING

INDEX

JULY—DECEMBER, 1917

VOLUME LIII

146798
30/8/18

ENGINEERING PUBLISHING COMPANY
INDIANAPOLIS, INDIANA CHICAGO, ILLINOIS

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VOL. LIII. — No. 1.

Municipal Engineering

The World's Leading Municipal Publication

JULY, 1917.

FULL SPEED AHEAD

It is the patriotic duty of every community and every citizen to transact all the business possible during the war. It is make or break now, and we aren't going to break—it isn't in the blood. Our bank deposits have passed all records. After nearly three years of war Canada is more prosperous to-day than ever before. She is in a stronger position financially than she has ever been; her industries are taxed to keep pace with the demand. Our experience will parallel Canada's, but at a much higher level. The days of uncertainty are over. We have many friends now among the nations, and are in a fair way to "straf" the Kaiser. Just think of those nine dreadnaughts in $9,000,000,000 and keep on sawing wood.

LET PUBLIC WORK GO ON

In times when national emergencies arise, or when general business is actually affected either by an excess or by a deficiency of prosperity there is sure to arise from some quarter the cry that "now is not the time to make public improvements." In 1913 and 1914, when the bread lines in our large cities extended for blocks and materials were plentiful and reasonable, public work slowed down in sympathy with general business. A few far-seeing public officials took advantage of the ample supplies of labor and materials and the corresponding low costs to speed up the work of improvements, but the total net result was a slackening of activity.

In the present situation when the United States is entering upon the most gigantic task in its history, the reactionary public official again comes forward with a seemingly plausible excuse for slowing down or stopping public betterments. A few governing bodies have gone so far as to commit themselves to programs of abolishing certain classes of improvements throughout the duration of the war. The excuse is that all resources of whatsoever character must be at the disposal of the government. It sounds patriotic, self-sacrificing, and grand; it attracts front page position and No. 1 heads in the press; it is a response to the national warning to economize. But it will not, in any large measure, bear up under the scrutiny of an analysis of conditions, and such "economy" measures are rarely accompanied by a reduction in the tax rates.

There are at least three very sound reasons why public work should go on in times like these. First, the slackening or stopping of public work does not, in any significant manner, assist the nation in its preparation for conflict; it may even hinder it; second, a public betterment needed in times of peace is doubly needed in times of war; third, certain industries which have been established largely or solely for the purpose of serving the public in connection with public betterments are adversely affected by such a policy.

It is stated that freight cars can be better employed in hauling materials to the munition factories and the finished product to the seaboard than in hauling paving materials to build roads, or in transporting equipment to carry on drainage work. If a shortage in railway rolling stock exists now, the situation will likely not be better as time goes on. Good highways would do much to relieve congestion on the railways. Food products are, we are told, to be scarcer than usual. Prosecution of drainage work would make available millions of new acres of rich agricultural lands. If our industrial centers and cities are to be crowded with laborers, and if our factories are to be busier than ever before in history turning out munitions and equipment for the armies, there is all the more reason why highways should be built as never before, why drainage should go on, why streets should be paved, why water works, light and power plants, sewerage systems, and public facilities of all sorts should be enlarged to meet the increased demands. But, it is said, the cost of doing these things are so high at present. If costs are to be counted in times like these, it must be remembered that any policy which makes for an accumulation of work to be done in the future is not likely to result in a reduction of costs. The need for public betterments is infinitely greater in times of war than in times of peace, and since the need is greater the justifiable cost is greater.

There are in the United States thousands of firms, the sole business of which consists in supplying materials and equipment which are used in public improvement work. They constitute an asset of great economic value to the country. It is not in the least sentimental to urge their right to continue their usual activities, especially when such continuance will serve so greatly to increase the efficiency, the certainty, and the economy with which the processes directly concerned with defense may be carried forward.

Let the public work go on.

It is a certainty that we will have a labor shortage in this country for years to come. It will doubtless continue after the war and may very easily be worse then than now. Our foreign trade will keep on growing and will call for more and more labor. We will also have our war losses.

American contractors have never had an easier decision to make than that of buying labor-saving machinery now.

STREET AND ROAD PAVEMENTS

THEIR DESIGN, CONSTRUCTION AND MAINTENANCE

Description of progress, including points on best practice in concrete road construction, as based on knowledge gained by inspection of concrete pavements in various parts of the country.

HELTINGE BREED, First Deputy Commissioner, New York Highway Commission, is our authority for the following description of the actual construction in New York state of 201 miles of second-class concrete pavements, 1:2½:5 mix, a type which is no longer used; and upon the actual construction of 364 miles of cement concrete pavement 1:1½:3 mix, built in the last four seasons. There still remain 127 miles of this type of construction under contract in New York.

Grades.

Grades are still treated differently in different sections of the country. Our original practice was not to exceed 5 per cent., but today we are building them as high as 8 per cent. under certain conditions. Grade seems to be limited only by the ability of the wet concrete to run during the process of construction, by the character of the mix and the kind of traffic to use it. Even on a steep grade, the use of a coarse sand prevents the roads from being slippery; and I believe that brooming of the surface facilitates the traction hold of all classes of traffic. Floating should be at a minimum, as this operation brings the finer particles to the surface, which gives a smooth top.

Accidents on Sixteen-Foot Roads.

In order to obviate the danger of accidents on our 16-ft. roads, we have been widening or mooning out the curves, so that in come cases for those of small radius at the center the actual curve is as much as 22 to 24-ft. wide.

We have also considered it good practice to give the outside of these curves a super-elevation in order to make easier the steering of a car, to lessen the likelihood of skidding, and to insure greater safety in taking these curves at speed. This has been objected to as inducing people to travel round these curves at high speed, but speeding seems to be an inherent mania, unrelated to external conditions, and certain it is that banked curves lessen the casualties resulting from it.

Specifications.

Cracking of a concrete pavement is generally due to the unequal settlement of a poor sub-grade. If the road is to be satisfactory, it is of first importance that a good sub-grade be secured. These we consider the essentials of a good sub-grade:

1. It must have uniform bearing power.

If an old roadbed is to be used it must be scarified, reshaped and rerolled for the entire width of the pavement, removing all large stone to a depth of 6 inches.

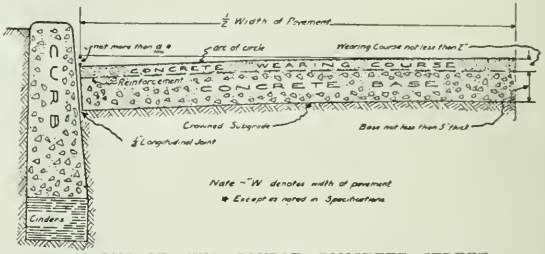
2. It must be dry.

Ditches should be low enough to take away the water from under the pavement. With unstable soil good results can be secured by providing sub-drains and spreading a layer of gravel—preferably run-of-bank gravel—over the sub-grade to increase its stability. Material used for this purpose must be impervious; if it is porous it will act during wet periods as a reservoir, which, under conditions of frost, will break the pavement proper.

3. It should have metal reinforcements.

(a) Under very bad, that is, unequal soil conditions.

(b) Wherever the supporting power of the sub-grade changes, as from rock to earth, or passing over a trench. Our experience indicates that the expense of reinforcement is not justified in gravelly or sandy soils where good natural drainage prevails.

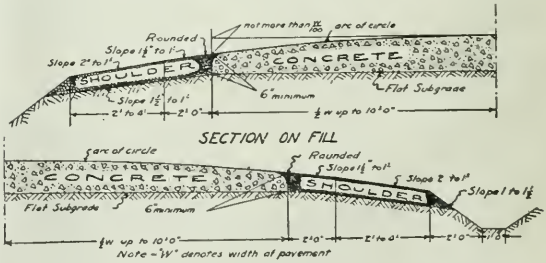


SECTION OF TWO COURSE CONCRETE STREET WITH CROWN AND SEPARATE CURB AND LONGITUDINAL JOINT BETWEEN CURB AND PAVEMENT.

The Mix.

The mix should be proportioned in such a manner as to give the greatest density. With our requirements for materials we have found that the proportions of 1:1½:3 most nearly do this. Our specifications provide that the concrete shall be mixed in the proportions of 1 volume of cement to 4½ volumes of sand and broken stone or gravel, and the proportions of fine and coarse aggregate are varied slightly as a result of field void tests so that the greatest density is obtained. Should the size or character of the materials change there would be a corresponding change in the proportioning of the mixture.

The coarse aggregate should consist of a well mixed product of clean No. 1, No. 2 and No. 3 stone or gravel. No. 1 size is that retained on ⅜-in. circular and passing a ⅝-in. circular screen. No. 2 size is that retained on ⅝-in. circular and passing a 1½-in. circular screen. No. 3 size is that retained on 1½-in. circular and passing a 2¾-in. circular screen.



SECTIONS OF CONCRETE ROAD WITH WELL COMPACTED BROKEN STONE, GRAVEL OR EARTH SHOULDERS.

It is provided, however, that not more than 25 per cent. of the total shall be No. 1 size, the proportions being so graded as to give a minimum of voids.

Aggregates should never be used unless they comply with the tests prescribed.

You may note that we allow, as our maximum size, stone

that will pass a 2¾-in. ring, whereas most specifications permit only 1½-in. stone as a maximum. This may seem radical, but our reasons for the increase in size is that we get equally as good, if not better, results from the larger stone, and at a cost decidedly lessened by our using more nearly the product of the crusher. Especially is the price to be considered on contracts where the local supply is crushed on the ground, as is the case in most of our work. If you desire economy, this change is worthy of your consideration. We save 15 per cent. in crushing costs by this use of stone larger than the previously accepted standards.

From a practical standpoint a pile of stone graded from ¾ to 2¾ inches has more stability when properly mixed than stone graded from ¾ to 1½ inches. In our 1916 work we used stone up to 2¾ inches in size; as an indication of the compressive strength per square inch of field cubes tested at an age of 28 days we have a grand average of 3,370 pounds per square inch for 504 cubes of stone and gravel, of which 13¼ per cent. were under 3,000 pounds. Greater density can be obtained by using stone up to 2¾-in. in size. With the large size stone there is less probability of spalling at joints and along edges.

Tests.

Theoretical tests are fine. They are necessary to tell you what you should have as a final product. You proceed on the hypothesis they offer and then you have to wait until service and climatic conditions prove how far your hypothesis conforms to realty.

Tests for concrete materials have never been given their proper consideration, with the exception of cement, which has been tested with all the finesse of the art of testing. In general little, if anything, has been done on the sands, which have been casually accepted if they looked good or had ever been used before in a structure that would stand up. As for the stone or gravel, all kinds and conditions of both have been used with practically no tests at all.

Our work has shown that if we are to omit any of the tests we might better take a chance with the cement, for of the last 455,000 barrels used, only 1 per cent. failed to conform to the test of the American Society for Testing Materials. Fifty per cent. of these failures was due to flash set and 50 per cent. to failure on the 200 mesh sieve requirement. Had all this cement been used, that rejected for sieve requirement would have given good work, and that rejected for flash set would have been aged enough by the time it was placed in the work to give good results.

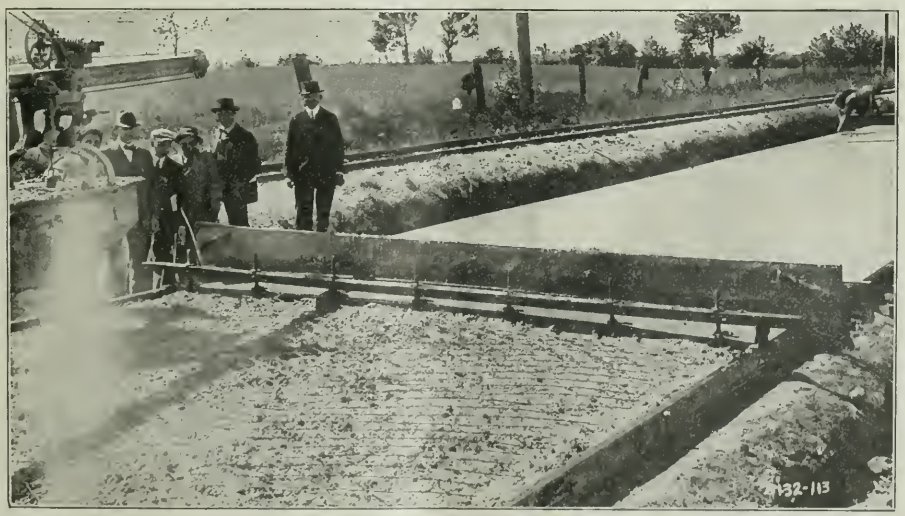
Engineering results presupposes judgment, so why not inject it into our problems? After priming ourselves with theory, let us apply it to practice. Let us make field tests that will parallel laboratory experiments; let us conduct our laboratories in such a way that their value may be significant to the man in the field, and so that their results may be checked up by him. Success of work depends upon the field man; in every case his personality helps determine the results. Put him in line with your tests, practices, etc., and his interest and co-operation will show most profitably in the work. All of our men, from the engineer in charge of the road up are instructed in all of these tests made and methods of inspection, and they complete them on every inspection of the work. We of New York state believe that our best results may be attributed to the esprit de corps engendered by this method.

Effect of Water.

According to Duff A. Abrams, Professor in Charge, Structural Materials Research Laboratory, Lewis Institute, Chicago, water is one of the essential ingredients in a concrete mixture. A certain quantity of water is necessary for the chemical reaction of the cement; a certain additional quantity is generally required for the purpose of producing a plastic mass which can be molded into any desired form.

There are a great many differences of opinion among engineers and contractors as to the influence on the strength and other properties of concrete as the result of differences in the quantity of mixing water used. A thoro experimental investigation of this subject is under way in the Structural Materials Research Laboratory. In the January number of the Concrete Highway Magazine the writer presented a brief discussion on the effect of excess water in concrete. The present article will furnish more definite information concerning the effect of varying quantities of water on the strength of concrete.

The diagram on page 4 summarizes the results of com-



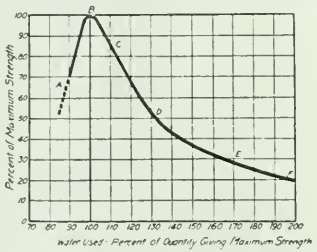
KAHN ARMOR PLATE FOR JOINT PROTECTION, SHOWING SPACES BETWEEN T-RAIL DEVICE AND PLATE WHICH ALLOWS PAVEMENT TO BE FINISHED FLUSH WITH TOP OF JOINT. KAHN ROAD MESH USED AS REINFORCEMENT.

pression tests on 6 by 12-in. concrete cylinders, made in mixes ranging from 1 part cement and 9 parts aggregate to 1 part cement and 2 parts aggregate by volume. These mixes represent concretes of all qualities, from the leanest to the richest, which are used for any purpose. The aggregate consisted of a mixture of sand and pebbles graded in size from the finest particles up to 1¼-in. Exactly the same grading was used in all cases.

These tests show that the effect of proportional changes in the mixing water is approximately the same for all mixes of concrete; consequently a composite curve has been drawn to show the average effect. The vertical distances represent the relative strength of concrete, expressed as a per cent. of the maximum which can be secured from a given amount of cement and the same aggregates. The horizontal distances indicate the relative quantity of water used in the mix, considering the amount which gives the maximum strength at 100 per cent.

The amount of water which gives the maximum strength in concrete produces a mix which is too stiff for most purposes. In plants where such products as building units, drain tile, sewer pipe, etc., are manufactured it is desirable to use a mix even drier than that which gives the maximum strength. The molds can thus be removed within a short time; this would be impossible if a wetter and more plastic mix were used.

It will be noted that the concrete strength increases rapidly with the quantity of water over the range indicated by A-B



CURVE SHOWING STRENGTH OF CONCRETE CYLINDERS.

on the diagram. With any further increase in the amount of water there is a rapid falling off in strength, as indicated by the curve BCDEF. With an amount of water about double that required for highest strength, the concrete has only about 20 per cent. of the maximum strength.

The exact amount of water corresponding to the maximum strength of concrete will vary with the method of handling and placing the concrete. Any method which involves puddling, tamping, rolling or vibration, or the exertion of pressure in any manner, will have a tendency to increase the strength of the concrete regardless of the amount of water used. However, it is probable that the effect produced by these methods will be more pronounced in the consistencies in the vicinity of the maximum strength.

In constructing concrete roads it is necessary to mix the concrete a little wetter than that giving the maximum strength. The consistency which should be aimed at in constructing roads corresponds to about 105 per cent. to 115 per cent. of that giving the maximum strength. In other words, a small portion of the strength must be sacrificed in order to secure a workable concrete. The economies resulting from handling the concrete are more important than securing the maximum possible strength for a given amount of cement.

Many contractors in constructing concrete roads insist on using quantities of water varying between 130 and 200 per cent. of that corresponding to highest strength. The effect of this practice on the strength of the concrete is indicated by the region D-F on the diagram. It is seen that in this case the strength is being reduced to about 50 to 25 per cent of what should be obtained by a proper consistency. It must be apparent that the wearing quality of a road constructed in this way is much inferior to that of a road made from concrete mixed to a proper consistency.

In building construction it is not uncommon to find concrete mixed with a quantity of water even greater than any used in these tests.

Few engineers or contractors realize the disastrous effects which are certain to accompany the use of too much mixing water. We frequently hear the following reasoning:

1. The excess water does no harm because it runs off and evaporates.
2. While very wet concrete is weak at early ages, it gains in strength more rapidly than the drier mixes.
3. The rich mixes used in road construction are less affected by excess water.

Table I.

Mix		Approximate Mix as usually Expressed			Water Required (gallons per sack of cement)	
			Aggregate			
Cement	Vol. of Aggregate after mixing	Cement	Fine	Coarse	Min.	Max.
1	5	1	2	4	6	6½
1	4½	1	2	3	5¾	6¼
1	4	1	1½	3	5½	6
1	3	1	1¼	2½	5	5½

The experimental work as carried out in this laboratory and elsewhere shows that none of these conclusions are correct. The use of excess water produces a concrete which is inferior for all mixes and at all ages. These tests also show that the excess water does not run off until consistencies are reached which correspond to those indicated in the region E-F and beyond. This indicated by the flattening of the curve which shows that the addition of water beyond that indicated by F has little effect. At this point a degree of "slopiness" is reached which gives only about 25 per cent. of the available strength.

The following questions are often asked:

1. What is the proper consistency for concrete road work?
2. How is this consistency to be determined?

These questions may both be answered in a nutshell by saying that for road construction the concrete should contain the smallest quantity of water which will produce a workable mix. It is evident that there may be a difference of opinion as to what constitutes a workable mix, but the diagram above shows that any reduction in the quantity of water within the range which should be aimed at in concrete road construction is accompanied by a rapid increase in the strength of the concrete.

The proper quantity of water will vary with the quantity of cement and the size and grading of the aggregate, and to a less degree on the nature of the aggregate. The water required for a sand and crushed stone aggregate is not appreciably different from that required of a sand and pebble mixture, providing the grading of the aggregates is similar. In case of very soft or porous aggregates (which, however, should not be used in road construction) a somewhat greater quantity of water will be necessary.

The quantity of water required will depend to a minor degree on such factors as the type of concrete mixer, method of placing the concrete, method of finishing, temperature, etc.

There is no direct criterion for determining in advance the best quantity of water for concrete being placed on a road. The concrete should be mixed so that only a small quantity of

free water will appear on the surface after leveling and striking off. This gives concrete of a jelly-like consistency.

The principal difficulty in the way of attempting to determine in advance the proper quantity of water for use in concrete roads is due to the fact that the aggregates are generally damp, and the degree of dampness is not uniform, but varies from time to time. In the case of concrete made of sand and pebbles or sand and crushed stone, well graded in size up to 1½-in., Table I indicates about the quality of water which should be used for mixes which are commonly employed in concrete roads.

This assumes, of course, that the aggregates are in a room-dry condition. Any moisture contained in the aggregates on the work must be taken into account. Most sand piled along the roadside will contain 3 to 10 per cent. by weight of water. In the table the water content is given in terms of gallons per sack of cement. It is not expected that these values will be of general application, since the quantity of water will vary with the size and grading of the aggregate, but they may be found useful in suggesting the limits which should be kept in mind in concrete road construction.

The Use of Side Forms.

The placing of side forms for a concrete road is too often done in a haphazard fashion. According to Mr. J. H. Anderson many forms are not properly constructed in the first place, with the result that they soon bend and warp or wear out of shape. In the second place, side forms are very seldom properly staked to line and grade.

The form setter, as a rule, when he desires to bring a form to grade, does so by inserting beneath it a small stick or stone, which is entirely insufficient to maintain the form to proper elevation under the saw-like pounding action of the strike-

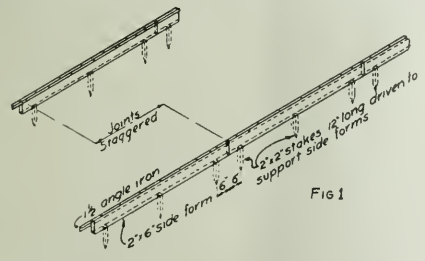


FIG 1

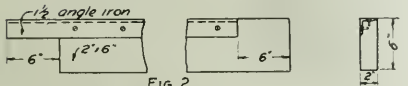


FIG 2

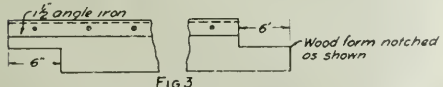


FIG 3

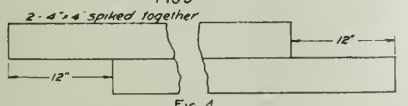


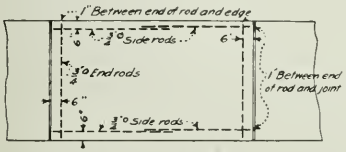
FIG. 4

SIDE FORMS FOR CONCRETE ROADS.

board. Frequently, too, the joints in forms on opposite sides of the road are placed directly opposite each other instead of being "staggered," as are the joints on a railroad.

Side Forms for Concrete Roads.

In Figure 1 is shown a method of supporting side forms to grade, which is easily applied. Note that 2x2-in. wooden stakes about 12-in. long are driven along the line of the side forms to the elevation of the bottom of the form. These stakes, of course, are intended merely to support the side form to the proper elevation, other stakes being driven in the regular way for the purpose of holding the forms in line. Note also that the joints in the side forms are staggered to prevent an undulation forming across the road in case the joints should be low. Figure 1 shows the use of wooden side forms with an angle iron at the top edge. This method of staggering the joints and supporting the joints to grade can be applied also to steel forms.


1" Between end of rod and edge
3/4" Side rods
6"
3/4" End rods
1" Between end of rod and joint
6"
3/4" Side rods
NOTE Reinforcement to be placed ½ way between top and bottom of slab.

QUANTITIES AND LENGTHS OF ¾" ROUND RODS* FOR 1 CONCRETE SLAB.

DISTANCE BETWEEN JOINTS	WIDTH OF ROAD IN FEET											
	18'			20'				24'				
	NUMBER AND LENGTH OF END PIECES	NUMBER AND LENGTH OF SIDE PIECES	TOTAL WEIGHT OF RODS IN SLAB POUNDS	NUMBER AND LENGTH OF END PIECES	NUMBER AND LENGTH OF SIDE PIECES	TOTAL WEIGHT OF RODS IN SLAB		NUMBER AND LENGTH OF END PIECES	NUMBER AND LENGTH OF SIDE PIECES	TOTAL WEIGHT OF RODS IN SLAB POUNDS		
25	2 18'-0"	2 25'-0"	129	2 20'-0"	2 25'-0"	135		2 24'-0"	2 25'-0"	147		
35	2 18'-0"	2 35'-0"	159	2 20'-0"	2 35'-0"	165		2 24'-0"	2 35'-0"	177		
40	2 18'-0"	4 21'-0"	180	2 20'-0"	4 21'-0"	186		2 24'-0"	4 21'-0"	198		
50	2 18'-0"	4 26'-0"	210	2 20'-0"	4 26'-0"	216		2 24'-0"	4 26'-0"	228		
75	2 18'-0"	6 26'-6"	283	2 20'-0"	6 26'-6"	289		2 24'-0"	6 26'-6"	311		
100	2 18'-0"	8 26'-6"	372	2 20'-0"	8 26'-6"	378		2 24'-0"	8 26'-6"	390		

* ¾" Bars may be substituted, reducing weights to 88% of those shown

FIG. 5. PLAN AND TABLE FOR CIRCUMFERENTIAL REINFORCEMENT.

Figures 2 and 3 show details of wooden side form construction. In Figure 2 the angle iron extends 6-in. beyond the end of the form to insure that adjacent forms will be maintained at the same elevation. Figure 3 shows a slightly different design, intended for the same purpose as the form shown in Figure 2. Figure 2 will be bent when the forms are handled roughly and in order to obviate this and still retain the benefits of this design, a form can be built as shown in Figure 3. Figure 4 shows a side form used by a contractor who happened to have a considerable quantity of old 4x4-in. timbers on hand. This side form was used for a road 18-ft. wide and a strikeboard was mounted on wheels. Due to its width, this form was very satisfactory for a strikeboard mounted on wheels, while, due to its rigidity and the method of forming the joints, a very smooth surface was obtained.

Proper placing of side forms costs but little more than does the careless placing all too frequently practiced, and the improved riding quality of the road and the increased satisfaction derived therefrom will compensate many fold for the slight extra expense.

Circumferential Reinforcement.

It has been observed by all who have given close attention to the matter, that where cracks occur in a concrete slab, they begin in most instances at the edge of the slab. Frequently they extend only a few feet. It has therefore been proposed that there should be a certain amount of reinforcement concentrated near the edge of the slabs. This has been designated a circumferential reinforcement.

While this form of reinforcement has not been used, it makes a strong appeal to all the engineers with whom it has been discussed. It is particularly to be urged in pavements of 20-ft. or more in width; and for pavements 24-ft. wide and over, in additio nto the usual mesh reinforcement.

TRENCH AND TUNNEL EXCAVATION

By J. F. Springer, New York City.

SEWER construction usually entails excavation—sometimes a very considerable amount. But this is not always the case. It will happen, occasionally, that a sewer is to run thru a district where the general surface at the time of construction is known to be considerably below what it is to be after filling in occurs. Or the sewer may follow the line of a ravine, which it is proposed to fill in subsequently. Or, the sewer may cross a valley. Here, instead of excavating, it may very well be that viaduct construction will be necessary. Finally, a sewer may cross a stream below its surface and excavation may or may not be needed. But, after all is said and done, the great bulk of the sewer construction is attended with excavation.

The excavation may be in the open—that is, it may consist of an open cut or a simple trench. It may, however, involve more or less tunneling. As a recent example, involving tunnel construction, may be cited the big Mill Creek sewer at St. Louis. There is an intermediate type of excavation, neither precisely open nor precisely tunnel work. I refer to excavation in large cities where the work may be of such a character that traffic in the street overhead must be provided for while excavation is going on beneath the surface. There may be necessity, in fact, to put in and adequately support planking for roadway use.

The simplest, ordinary type of sewer construction requires the opening up of a trench or open cut. This may be merely an ordinary digging operation. Sometimes, however, we soon encounter rock. Sometimes we find that we have water with which to contend, or it may be earth and water in the form of quicksand. If the trench has anything more than a very insignificant depth, we will often find that we must support the sides of the excavation as well as dig out the material.

The simplest tools used in trench work are the pick and the shovel. Their use is still common. It will be important to be able in advance to estimate the expense of using men with these tools. R. P. Gillette gives, partly on his own authority and partly on the authority of others, certain figures. I excerpt the following in the form of a table:

WORK PERFORMED BY ONE MAN WITH PICK AND SHOVEL.

Material	Cu. yds. handled in one hr.
Hardpan	0.33
Common earth	0.8 to 1.2
Clay (stiff)	0.85
Clay	1.00
Sand	1.25
Sandy soil	0.8 to 1.2
Clayey earth	1.3
Sandy soil (frozen)	0.75

Such figures must be used with discretion. For one thing, the type of laborer to be used and the character of the immediate supervision play important modifying influences. At the same time the foregoing figures afford us a fair guide. It will be understood, perhaps without my saying it, that when the trench gets quite deep the shoveling will naturally slow down. To shovel loosened material into wagons may be done at the rate of 2.3 cubic yards per hour; but this is to be regarded as exceptionally good work and not to be depended upon ordinarily. A lower rate, say 1.8 cubic yards per hour, will cover the general case better.

The Horse and Plow.

Instead of the pick and shovel, the horse and plow may often be used at the beginning. Undoubtedly, wherever the use of the plow is practicable, money may generally be saved. To be effective, the plow must move over some little stretch. Naturally its use will be discontinued after it has penetrated a short distance down. It is understood that a two-horse plow with one man to drive and one to manage the plow is more economical than a one-horse plow. Four-horse and even six-horse teams may at times be advantageous. But, whenever extra men would have to ride the plow team, a steam roller or a traction engine may prove more economical.

The plow drawn by horses or other means is very useful in opening up a trench where the surface is part of a paved street, where it consists of very hard and compact soil or where the soil is frozen. Hand methods in such cases are scarcely economical. Frozen soil may sometimes be drilled and blasted. This will depend largely upon the question of safety to people and property in the neighborhood. If the plow is, for any reason, unavailable for removing frozen soil, we may thaw out the soil by fires built during the night.

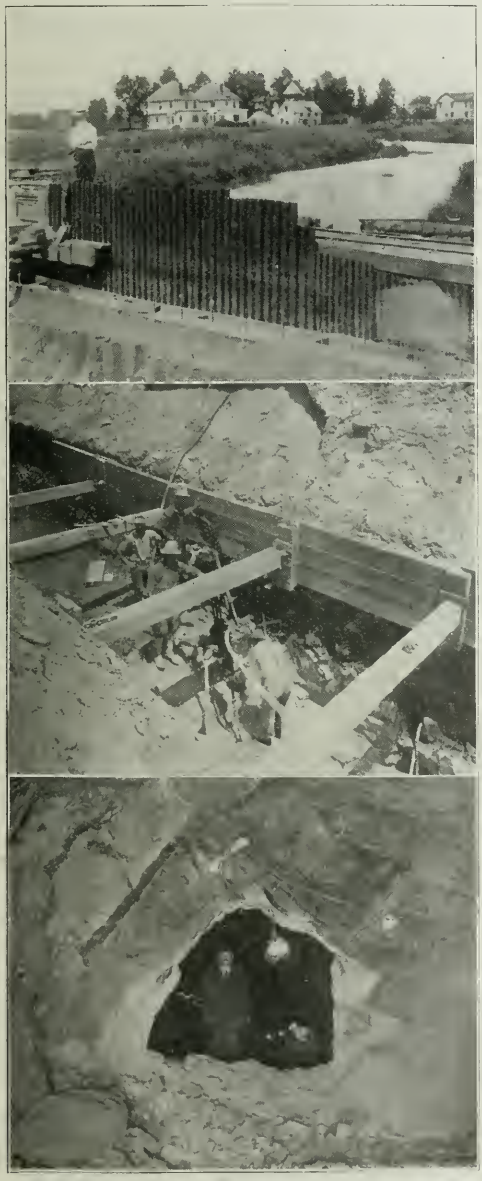
The Use of Steam.

A more elaborate, but probably more effective, method is to thaw out frozen ground by the aid of live steam. The steam may be applied in the following way: A number of tight wooden boxes are prepared, each box having a height of 10 or 12 inches. The length may be a dozen feet or more.

EXTENSIBLE BRACES IN PLACE IN A TRENCH EXCAVATION.

These boxes have their bottoms open. When placed in position, they will form a line of covers for whatever length of trench it is proposed to treat during a single night. The tops of the boxes should be pierced by holes of a size to just permit the introduction of a ¾-inch gas pipe. The holes should be distributed over the top, one being provided for about every two square feet of surface. Along the sides of the boxes, earth should be banked to provide a seal against the escape of the steam or warm air, with which the boxes are to be filled during the thawing operation. A steam boiler will be located nearby and a flexible connection arranged of sufficient length to permit the steam to be transmitted to all points along the row of boxes. To the further end of the hose, a piece of gas pipe, perhaps half a dozen feet long, will be fitted. The holes in the boxes should all be provided with plugs. When all is ready, the man attending to the thawing will

remove a plug and introduce the gas pipe, the latter being provided with a suitable cross-bar securely attached, to facilitate handling and working the pipe. The workman holds or sets the pipe vertical with its open end in contact with the frozen ground. The steam will at once begin its work of thawing. As the thawing goes on and the ground softens, the workman will be able to work the pipe down into the ground and thus thaw it out as far down as desired. When he has dealt with the soil to the full depth at one of the holes, he withdraws the pipe and plugs up the hole. He now attacks the soil thru another hole, and continues the thawing until the work is complete from one end of the row of boxes to the other. It is understood that one man will be able to thaw out in the neighborhood of 35 cubic yards of frozen material in one night. This man will also care for the boiler. The service performed by the boxes is to maintain a warm blanket over the surface being treated.



VIEWS SHOWING FEATURES IN UNDERGROUND CONSTRUCTION: 1—LIGHT WEIGHT CORRUGATED SHEET STEEL PILING AS USED IN TRENCH WORK; 2—TRIPOD DRILLS IN DES PERES (ST. LOUIS) FOUL WATER SEWER; 3—MEETING OF HEADINGS IN HUDSON RIVER SIPHON TUNNEL. POINT SHOWN IS BENEATH RIVER NEAR WEST POINT, N. Y.

The Wakefield Pile.

Sometimes the soil will maintain itself in a vertical wall without aid. But, even in such cases, no deep trenches, except sometimes in rock or the like, should be excavated without adequate protection being provided against the falling in of the side walls. It is best to take absolutely no chances, because the matter involves safety to life and limb. The maintenance of the side walls is provided for by the use of steel or wooden sheeting. In either case, the individual sheet piles may often be driven down to full depth prior to excavation. Under other circumstances, the sheeting will be put in after the excavation is partially done. Wooden piling may consist of simple planks standing side by side, the planks in a vertical position. The thickness will be determined by the service to be performed. That is to say, if the pile has to be driven in advance of excavation, it will have to be stout enough to withstand the driving operation as well as strong enough to resist any horizontal pressures from earth and water. If the service to be performed by wooden sheeting is very exacting, Wakefield sheet piles may be used. These provide a tongue-and-groove interlock, which assists in mantaining the wooden wall as a whole and excluding water from entering the trench from the strata back of the piles. This type of sheet pile may be readily made on the spot, and there is no question of patent infringement. To make a Wakefield pile, we may spike together three planks, all of the same thickness and the same width. The top plank is placed precisely over the bottom one. The intermediate plank parallels the others, but it is displaced somewhat to one side, thus providing a tongue on one side of the pile and a groove of equal depth on the other side. To drive this pile, we sharpen the end which is to pilot the penetration and use any convenient method of pile driving that may be available at the time. While this sheeting has a good, serviceable interlock and may be counted upon for a fair degree of watertightness, still the interlock does not secure the piles in all horizontal directions. That is to say, earth and water pressures from behind may produce a bellying action resulting in the parting of the interlocks at various points. However, this may usually be prevented by adequate bracing.

Sheet Steel Piling.

The best types of steel sheet piling now on the American market have ordinarily an interlock of such character that it will resist opening up in consequence of horizontal pressures. Some of these types may be made quite watertight, if desired.

Sometimes, especially if the soil is dry, the sheeting need not extend to the bottom of the trench. At other times, it will be advisable to run the bottoms down below the level of the excavation. Where sheeting is used to exclude water as well as safeguard the side walls, it will sometimes be advantageous to drive it down until the feet of the piles have well penetrated into an impervious stratum. We may in this way often succeed in cutting off practically all water, the sheeting itself excluding the water from horizontal entrance and the stratum of clay or other impervious material preventing it from coming in from beneath.

Steel sheeting may be gotten almost any length. Unspliced

steel sheet piles 72 feet in length were used at New York in constructing the open cofferdam for excluding the Hudson River from the waterfront at Forty-sixth street. Long lengths may be made up by splicing, this operation being done during the driving. With wooden sheeting, approved practice would seem to limit the lengths of the individual piles. Considerable depths of ditch may be realized, however, by a kind of splicing. That is to say, the trench will be carried down at various widths, the width narrowing as one goes down. An unspliced pile is alloted to each stage. Thus, at Louisville, Ky., a deep sewer trench was put down in three stages. Ten and twelve foot piles were used with overlaps of 14 inches. The trench was 6 2/3 feet wide at the top, 5 1/3 feet through the final stage. At the overlaps, wales or rangers were interposed between the two overlapping walls of sheet piling. At a short distance below such an overlap, a line of wales was arranged.

The braces which are used to hold the wales up against the wooden or steel walls may be simple sticks of squared timber or they may be special braces capable of being lengthened and shortened while in position. Such special braces are obviously convenient.

The sheet piles will be driven more or less in advance of excavation or simply placed against the side of the trench after it has been dug at least to a depth equal to the length of the piles. In this latter case, it is very necessary to trim the sides of the excavation to a plumb line in order that the sheet pile may bear throughout its length.

Short Vertical Pieces.

A modified form of vertical sheeting is where short lengths are used, these being placed subsequent to the excavation of the region they are to protect. An advantage consists in the fact that the excavation need not be carried far without protection for the side banks already dug. Such short vertical pieces are sometimes called poling boards. It may at times be possible to use only a single line of wales to a stretch of such short pieces; but at other times two lines may be required. Poling boards afford an easy, cheap method of shoring. There is a disadvantage, however. In case material slips away from behind the poling boards, they may give way and cause an extensive break-up of the shoring.

Before leaving the subject of sheeting, braces, etc., it may be as well to call attention to the advisability of using cleats with wall braces as a protection against the braces falling.

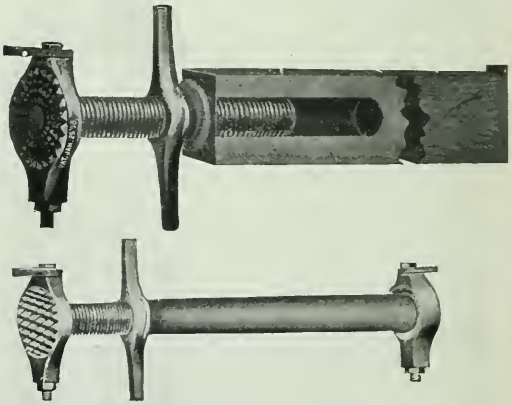
The sides of a trench are sometimes protected by the use of wooden planks laid horizontally. This method has certain advantages. In the first place, we maintain a protection to the walls only a matter of inches behind the excavation. We need excavate but a little, when an additional plank may be put in. Further, it is not so necessary to maintain absolute verticality of the sides of the excavation, as the planks may readily accommodate slight deviations. This type of sheeting is sometimes termed *box sheeting.*

It will readily be seen that extensible braces are especially adapted for use with horizontal planks, as they readily take care of moderate variations in the horizontal distance from plank to plank across the trench. The cross braces may be put in temporarily to secure a single plank on the two sides. Later, vertical strips may be used to cover several planks and the number of braces reduced by arranging them to bear against these strips and not directly against the planking.

Extension Braces.

Extensible braces are valuable not only because they are convenient and tend to expedite the work but also because they eliminate the necessity of hammering and thus producing shocks to which the sides of the excavation may be more or less susceptible. This is to say, when we screw up an extension brace in order to make it press against the planks or strips or wales against the walls of sheeting, we are lightening the brace in a gentle manner; but when we drive in a wedge at the end of an ordinary brace, we may produce shocks which have objectionable results.

Sometimes, tho perhaps not so very often, sheet piling with a good interlock will need no cross bracing or other special means of holding it against earth and water pressures. The piling itself has a degree of stiffness which is naturally increased by the secure interlock. As a rule, longitudinal braces—that is, *wales*—will be used. Cross braces may be put in to brace one wall against another. With piling driven a short distance below the trench bottom, the wales and cross-braces may often be omitted in the bottom part of the excavation. This may be quite an important thing, as such omissions leave free working room. It may often be desirable to have no cross braces at all. There is a way to omit them, even where the earth and water pressures are severe, but it is not conveniently applicable to all cases. Sometimes it may happen that the region to either side of the trench is to receive a fill. It may then be possible under these circumstances to locate "dead men" sufficiently off to either side of the trench to give them proper resistance and to tie the wales to these "dead men" by steel rods provided with turnbuckles. The "dead men" may be held in position by surrounding them with conical piles of earth and rock. Naturally, the "dead men" will be set up vertically or obliquely in order that more than one line of wales may be tied back to the same "dead men." Of course, if only a single line of wales is to be used to each wall of sheeting, then the "dead men" may be laid horizontally.



SPECIAL EXTENSIBLE BRACE FOR USE IN TRENCH WORK. NOTE THE LUGS FOR PREVENTING BRACE FROM FALLING ACCIDENTALLY.

Horizontal "Dead Men."

It is not absolutely necessary that the point of attachment of a tie rod to a wale and the point of attachment to a "dead man" be both at the same level. This makes it possible to use horizontal "dead men," even where there is more than one line of wales to a wall of piling. It also makes it possible to locate "dead men" at up-hill and down-hill positions.

Indeed, a line of "dead men" may be used whether the general surface is horizontal or slopes up or down from the trench. A "dead man" may be set partly in a pit and partly outside. It should be remembered when using oblique tie-rods that they need to be heavier than horizontal ones to withstand the same horizontal thrusts.

The foregoing facts as to the possibilities of eliminating cross braces is important, as such elimination gives a free, unobstructed trench.

(*To be continued in August issue*)

Vermilion County Highway Improvements

Engineers' and Contractors' Methods Described by Mr. P. C. McArdle, Chief State Highway Engineer and Superintending Engineer, Vermilion County (Ill.) Board of Supervisors.

OUR ENGINEERING force, comprising the engineers division, worked up the estimates, each on his own division and checked the estimates of another division. All end areas were calculated by the use of the planimeter, from cross-sections made every 100 feet, and the cubical contents by a comptometer. These were checked by slide rule; all operations were checked at least once. Our division engineers are called together frequently and instructed in their duties before going into the field.

Each engineer is furnished with a transit equipped with level bubble, level rod, steel tapes, thermometer, scales, a set of sand and a set of gravel screens, field books, loose-leaf note books and such other supplies as he might require. A record of instruments and supplies received by each engineer, is filed in the office and charged against him till their return. The bookkeeper keeps the record of auditing the purchase of all supplies; prepares all vouchers for presentation to the County Auditor, and our committee for approval and payment. The assistant engineer receives, examines and files all reports.

Testing of Cement.

All cement is tested by the Pittsburgh Testing Laboratory under contract with the county. Complete tests are made on each carload in accordance with circular No. 33, United States Bureau of Standards. The company notifies the division engineer promptly upon the acceptance of a car of cement. Complete test reports are sent, one to our own office, and one to the State Highway Engineer. In order to check upon their tests, samples from each tenth car are submitted by the division engineer to our own laboratory. In addition, the State Highway Department independently samples and tests this material. All sand and gravel are examined upon receipt by the division engineer, and in case of dispute between him and the contractor, samples are sent to the office for test. The crushed stone received is tested by our inspector before shipment, and 941 cars were so tested this year.

	PAVEMENT LAID 1916.			PAVEMENT TO BE LAID 1917			
DIVISION	NO DAYS PAVING 1916	LIN FT PAVEMENT LAID 1916	AVERAGE LIN FT PER DAY 1916	TOTAL LIN FT PAVEMENT IN CONTRACT	NO WORKING DAYS 1917	LIN FT TO BE LAID 1917	AVERAGE LIN FT PER DAY 1917
1	55	22135	402	105204	125	83069	664
2	57	14230	250	106040	125	91810	735
3	112	26843	222	95369	125	68526	548
4	106	57312	541	69785	125	12473	100
5	87	47370	544	97529	125	50159	401
6	4	608	152	90548	125	89940	719
7	75	27003	360	96102	125	69099	553
8	89	38506	421	103776	125	65270	522
9	91	28225	312	111817	125	83592	668

STATUS OF WORK IN MILES, DECEMBER 9, 1916

DIVISION	EXCAVATION	SUB-GRADE	COARSE AG	FINE AG.	PAVEMENT	SHOULDERS	ROAD COMPL
1	11.00	6.25	4.87	4.41	4.41	3.57	
2	4.10	3.06	3.06	3.06	2.68	2.50	
3	6.42	5.17	5.12	5.12	5.12	4.19	
4	13.09	10.81	10.81	10.81	10.81	7.39	7.39
5	9.11	9.11	9.11	9.11	9.11	6.09	2.00
6	4.00	0.75	0.12	0.12	0.12		
7	6.25	5.17	5.09	5.15	5.12	4.70	3.13
8	14.50	7.35	7.35	7.35	7.35	5.50	4.81
9	5.45	5.45	5.45	5.45	5.36	0.50	0.50
TOTAL	77.92	53.12	50.98	50.58	50.08	34.44	17.83

Tests are made on each car load of paving brick received on the work. The brick are loaded at the plant by the brick company under the direction of our own inspector, who also selects ten samples from each car shipped. These pieces are tested separately and reports are made to the State Highway Department on each car, and a copy is kept in our own files. The brick are also inspected by the division engineer or local inspector on the job.

SCENES ON VERMILION COUNTY BOND ROADS: (1) PAVING DIVIDED TO PRESERVE TREE; (2) SIDE LOADING MIXER IN OPERATION; (3) STRETCH OF ROAD RAISED AND PAVED.

Every safeguard known to the engineering profession is used to insure that the county receives the best possible quality of material of every character required by the specifications and contract.

Laboratory Work—Season 1916.

Material	No. tests Bond Roads	No. tests for Co. Supt. Highways
Cement	35	20
Sand	23	3
Stone	6	..
Gravel	18	4
Shoulder Material	15	..
Brick	132	52
Total	229	79

Cement tests from each car by Pittsburgh Testing Laboratory, 455 tests; stone tests by inspector at plant of Brownwell Implement Company, 941 tests.

Method of Constant Inspection.

As previously stated, the division engineer acts as inspector of the materials and workmanship of his division. The superintendenting engineer took upon himself personally, to travel over the work in every division at least once in each week, and as much oftener as each occasion demanded. This involved his traveling from 50 to 150 miles each favorable day, making in order to accomplish this purpose, over 14,000 miles during the working season.

The State Highway Department, also furnished a resident engineer, in charge of inspection of the county road work, who also constantly traveled over the work in a Ford touring car inspecting the work for his department. These men were given every facility by our engineers to examine into our methods of inspection and to offer suggestions for the better performance of the work.

(1) MONOLITHIC BRICK CONSTRUCTION ON VERMILION COUNTY ROAD. (2) DUMPING TRAINLOAD OF STONE FOR DIVISION NO. 4.

Contractors Methods.

All contractors, with one exception, use some unloading machine. Two are using Byers Auto Cranes with clam-shell, two belt conveyers, one stiff-legged derrick with clam-shell, one a cable and bucket, two locomotive cranes and one is unloading by hand labor.

Contractors, by study of the topography of the county thru the use of grade maps furnished by our office determined that the hauling of material by industrial railway was the most practical method of getting material to the jobs. This is evidenced by the fact that seven of the nine contractors are using this method of haul.

All are using storage bins in connection with unloading devices. All of these outfits have given satisfactory service, tho the stiff-legged derrick and locomotive cranes give the wider range of usefulness, being capable of unloading into stock piles, direct into cars, or into storage bins as occasion demands.

Weekly Charts.

Weekly charts of the work are prepared by our division engineers. These are mailed to the office on Monday of each week. Copies are made. One for each division is posted on the bulletin board in the office, and one of each is mailed on Wednesday to the State Highway Department at Springfield, so that the officials may be constantly advised of the progress of road work in the county. A weekly blue print tabulation also is prepared for the use of the chairman of the committee and the superintending engineer.

From time to time, there was prepared and sent to contractors, a tabulation showing the daily average work done to date and the daily work necessary to complete the several contracts within the specified time. These reports show that a little over 50 miles of pavement were placed during the year, and that in addition, 28 miles of excavation were made in preparation for 1917 work. Of the mileage completed, 43 miles were of concrete and 7 miles of brick and of this mileage the State Highway Department has accepted and taken over the maintenance.

Side Loading Mixers.

On divisions 3 and 8, the contractors, A. D. Thompson Company, and P. M. Johnston Company, arranged to use side-loading mixers and dump the concrete materials direct into the mixer hopper. The method is satisfactory from the standpoint of the county in that mixed materials are discharged from the drum without an admixture of clay or loam, which is difficult to avoid when materials are dumped upon the subgrade and later shoveled into the mixer. The disadvantage of the method is the delay due to derailments or accident to unloading outfit, when all work stops till repairs are made, while with the older method, materials may be stored on the subgrade miles ahead of the mixer and when accidents occur, the mixer may still be operated on full capacity while repairs are made to the hauling or unloading outfit. Similarly, when accident occurs to mixer outfit with direct loading, all the outfit is tied up again till repairs are made, while with the dumping on subgrade, hauling and unloading outfits continue work till the mixer is repaired. A photograph shows one of these mixers in action on division 8.

Efficiency Methods in Street Cleaning

How New York City Lowered Costs While Extending Service and Increasing Wages.

INCREASING service and wages while lowering costs is the proud record of the department of street cleaning of the city of New York. This record, made and sustained during the last three years, rests upon root and branch improvements in organization, equipment and methods.

Outstanding Feature in Brief.

Some of the salient features in this fine record of better results at lower costs are: Clean street area increased; cost of regular work in 1916 lowest in six years; increase during last three years of $26 in the annual wage of the employe over that of the preceding three years; collection service improved; per capita cost lowered 26 cents per annum; total saving to city in three years, $1,143,000; 4.43 per cent. increase in amount of ashes, garbage and rubbish handled in 1916 as compared with 1913; 3.35 per cent. smaller force in 1916 than in 1913; instituted system of instruction of men in standard practices; established model district, securing improved service at lessened cost; constructed three new, modern, covered, sprinkler-equipped dumps, minimizing dust and odors; instituted improved purchasing methods; negotiated new garbage contract that increases city's revenue $100,000 a year; reorganized clerical force and systems of accounting, and in many ways added to the contentment and welfare of the force.

Snow Removal Methods Revolutionized.

The major achievement of the department has been its revolutionizing of snow removal methods. The rate of removal has been more than trebled, while the cost per cubic yard removed has been reduced 68 per cent. At the average cost per cubic yard of the four preceding winters, snow removed in the last two winters would have cost $5,394,159 more than was actually expended on that account. Many thorofares formerly entirely neglected have been cleared during the past two winters and are now scheduled for snow removal. The old custom was to wait until a snow storm had ceased before beginning snow removal. The new custom, inaugurated by the present administration, under J. T. Fetherston, commissioner, is to begin removal while the snow is still falling. Mr. Fetherston's latest annual report, released June 7, 1917, gives this information on snow fighting methods and results.

Considered from the viewpoint of the public and measured by the effect upon business interests and the personal convenience of citizens, it is probable that the changes in methods of snow removal represent the most noticeable feature of this administration's progress. The time-honored system of removal by contractors has been amended to the extent that the city now does the larger part of the work, by the direct employment of labor and the use of department equipment. Owing to contracts in existence when the present administration assumed direction, application of the new principles was confined in the winter of 1913-1914 to a limited use of sewers for snow removal.

As a result of the winter's experience and tests that were made, it became apparent that the city had had available for years a possible solution of the problem of rapid snow removal, thru the extensive use of sewers, not alone after a snowfall, but during the progress of the storm. The experience of that winter demonstrated to the satisfaction of this administration that snow work should be started with the storm and clean snow dumped into the sewers as it falls. Such methods imply an attempt to keep pace with a storm,

CLEANING SNOW FROM NEW YORK STREETS.

PANNING SNOW INTO SEWERS.
PLOWING THE ACCUMULATION TO STREET CENTER.

HOW FLATCARS AIDED IN RAPID DISPOSAL.
KEEPING STREETS OPEN VIA MOTOR SNOW PLOW.

instead of trying to dig the city out after a blocking of traffic has occurred.

Systematic Preparation for War on Snow.

In the summer and fall of 1914, the department made preparations to apply during the following season its new program for handling snow. This preparation included a thoro survey of the city's sewer system, specialized instruction of the department's forces, enlargement of standard equipment, enrollment of emergency workers as "snow fighters" and the platting of the city so that practically 50 per cent. of its entire area could be cared for by the simultaneous attacks of the "snow fighting" gangs, within four hours after the call to go to work. Plans called for pushing snow into sewer manholes by the use of pan-scrapers operated by hand, and drag-scrapers, each drawn by a single horse.

These plans did not eliminate contract snow removal, as large quantities of snow still had to be carted to the river dumps or main sewers; nor did they release the city railways from their obligations to clear the snow from certain streets carrying railway tracks. But up to this time the city had depended upon trucks alone to haul snow from the streets to water front dumps and, consequently, the speed of snow removal had depended upon the supply of trucks available for the work.

New Methods of Snow Fighting Successful.

Results of the application of the new system during the winter of 1914-1915, as compared with preceding winters, showed that the rate of removal doubled as compared with the best previous record, and that the cost per cubic yard decreased 67 per cent. compared with lowest previous unit cost record. The total fall of snow for the winter was 22.4 inches, and the total cost of removal was $523,892. If the entire snowfall of the winter had been handled by contractors' trucking forces alone, at the lowest previous contract rate ($0.367 per cubic yard), the cost of the season's work would have amounted to $1,584,822. The total area of the streets in the three boros scheduled for snow work in the winter of 1914-1915 was 32,607,081 square yards, or 927 miles of streets.

Snow Plows Meet an Emergency.

When the first snow of the winter of 1915-1916 arrived, it found the department further strengthened by valuable additions to its equipment and better trained organization; but the beneficial effects in these improvements were counteracted, to some extent, by the shortage of labor available for emergency snow work. Schedules called for 14,737 emergency laborers, working in nine-hour shifts, while storms were in progress. The average number of men secured was 9,060, or 61 per cent. of the required number. Use of snow plows, designed by the department and attached to commercial motor-driven trucks, aided in reducing the effect of the shortage of labor. These plows were used for piling snow in the center or on the sides of streets.

Over 50 inches of snow fell during the winter, compared with the average fall of 32.2 inches. The total area scheduled for snow work in the three boros had increased to 33,311,899 square yards, which represented 946.17 miles of streets. Nearly 12,000,000 cubic yards of snow (truck capacity basis) were removed at a gross cost of $2,521,299.55, or at the rate of 21.2 cents per cubic yard. This was more than double the quantity (truck capacity basis) removed by the city during any previous winter season, and the cost was less than half the average cost per cubic yard for the previous seven years. No serious complaints were made regarding snow removal during the season, which is creditable to speedy action in opening main arteries with automobile snow plows, employment of the largest procurable force of emergency laborers during storms and the use of sewers for the disposal of snow.

Highest Rate of Snow Removal.

Including the statistics of the snow storm of last December the total fall of snow for the calendar year 1916 was 54.6 inches, averaging for the previous forty-seven years 32.16 inches. The daily rate of removal during 1916 was 198,000 cubic yards, compared with the grand average, 1907 to 1915, inclusive, of 71,886 cubic yards. Rate of daily removal during and following the storm of December 15 last surpassed all previous records. There was a snowfall of 12 inches. The cubic yards removed totaled 2,178,301. Nine days were required for completion of the task, the daily removal approximating 242,000 cubic yards. This record was achieved despite a shortage of labor, because of the almost perfect working of the system established by the department. An important feature was the use of 120 city snow plows driven by commercial motor trucks.

Snow Fighters Registered.

There were on the registration lists of emergency workers or "snow fighters," at the begining of 1916 a total of 13,426 names. During the storms of February and March an approximate average of 60 per cent. of the total number registered were actually secured for the work. During November and December, 1916, the registration of emergency workers was 9,082; approximately 45 per cent. of those registered reported for work on the storm of December 15, during which 12 inches of snow fell. The total snowfall for 1916 was 52 inches. The total area of streets from which snow was removed was 24,459,686 square yards, and the length of the streets 695 miles. Some snow was removed by contract in 1916. This covered 5,748,460 square yards of street area and 163 miles of streets.

An inventory of the machines and tools assigned to snow removal work, on the last day of 1916, gave: 169 auto plows, 83 horse-drawn plows, 4 sand spreading machines, 100 bags with auto plow parts (carried on auto trucks for making minor repairs to auto plows in the field), 20 boxes with auto plow parts (in stables), 19 boxes with auto plow repair tools, 13,264 pan-scrapers, 7,524 shovels, 7,436 picks, 885 bleeding poles, 22,321 red flags, 194 flashlights, 335 hydrant pumps, 1,140 hydrant keys, 411 nozzles, 255 reducers and 945 hose lengths.

The average daily rate of removal for the two years, 1911-1913, under the old method was 51,390 cubic yards at an average cost to the city of $1,535 per cubic yard. Under the new method, 1914-1916, the average daily rate of removal for the two years was 234,211 cubic yards, at an average cost of $0.188 per yard.

Had the old methods and contract prices prevailed during the winters of 1914-1915 and 1915-1916, the total cost of snow work would have been $8,682,792.66 instead of $3,045,191, or a difference of $5,637,601.66 in favor of the new methods.

Methods of Increasing Efficiency of Entire Force.

Scrutiny of the methods of performing the important functions of the department, in force when Mr. Fetherston took charge, disclosed a condition, in which there was an almost entire absence of system. Each district had been permitted to devise its own way of doing the work; there were almost as many different ways of doing the same things as there were working districts in the city. Apparently, the department had been conducted upon a theory that any one who had the physical strength to manipulate a broom or lift a can filled with refuse matter was qualified as a sweeper or driver.

Inspired by the conviction that the quality of the service rendered by the individual employe would be greatly improved if each was carefully instructed and trained in the work assigned to him, a campaign of education was determined upon. It was decided that the first step in carrying out this plan should necessarily be a thoro inquiry into the methods employed theretofore, with a view to the elimination of

the inefficient and wasteful; this to be followed by the strengthening and standardization of the efficient.

In undertaking this work the head of the department took counsel from every available source, having the support of scientific knowledge of the problems to be dealt with and from those whose practical experience made valuable their suggestions and opinions. The matured thought of the engineer was then brought into contact with the actual experience of men who had gained their knowledge and formed their opinions in the field of the department's operations.

Standard Methods Adopted.

Field officers, some of whom had been in the service twenty or more years, were called into conference with the head of the department and his engineers, and a thoro analysis of past methods of this city and elsewhere (as far as possible), together with new and advanced thought, was had. The tangible result of these conferences was the adoption of standard methods for the performance of the several branches of the work. A series of booklets, clearly setting forth in detail the approved method to be employed in the performance of each phase of the work, was printed, and each responsible officer of the department was supplied with a complete set of the booklets, with instructions to observe strictly the rules laid down.

The result of this procedure was to fix uniform methods thruout the territory under the jurisdiction of the department. All districts are now striving to reach the common plane of performing the same work in the same way, giving the service the benefit of the best methods of each district, fortified by new and approved features, and discarding the inefficient and time-wasting.

To secure the best results of this standardization, it was apparent that not only should the officers be instructed and drilled, but that the men under them should be trained. Right there was found the most difficult factor in developing the new system. Sweepers, drivers and other workers who have become accustomed to generally following their several respective ways of doing things—frequently starting wrong and never getting right—have much to unlearn before they become amenable to new teaching. "It's difficult to teach an old dog new tricks." While it is the policy of the administration to insist that the officers require observance of the methods set forth in the books of rules, it is understood that there are habit-formed obstructions to adaptability.

A School of Instruction.

To assist in solving this difficulty and to provide for its gradual removal, a school of instruction was established, in which all recruits are given a practical education in their duties and in the methods of performing work. Men who have passed the civil service examination and have been recommended for the sweeping, driving or other uniformed division of the force, are given courses of instruction in the school before being assigned to regular positions. Competent instructors are in charge of the classes and using the above mentioned books of rules as text books, and in simplified manner making perfectly plain every detail of approved methods of performing the work, they instill into the minds of the beginners correct principles and train their hands to the most efficient application of these principles. The school also inculcates in the minds of new city employes their responsibility as temporary custodians of city property in the form of tools and machines, and impresses upon them their obligation properly to conserve such property.

During the seven months that the school of instruction has been in existence it has trained and turned out for active service, 183 sweepers, 148 drivers, 30 chauffeurs (20 of whom are tractor drivers) and one craneman. Special courses of instruction have also been given to 340 officers of the department during the same period.

It is believed that because of the training given the men who are newly recruited for the service, there will be a constant and perceptible improvement in the quality of the work performed by the individual worker. This in conjunction with an established system for the whole department and officers trained so uniformly direct the work along lines of greatest efficiency will inevitably produce results gratifying to the public and the department.

THAWING WATER PIPE TRENCH

A practical and economical method of thawing out a trench for the relaying of a frozen water main was worked out by Edgar S. Smith, Superintendent of the Water Department of Pocatello, Idaho, and is described by him as follows:

The city of Pocatello, Idaho, has experienced the longest siege of cold weather during the past winter ever recorded there, with the result that thirteen blocks of 4-inch cast iron mains were frozen with an 80 per cent. loss of pipe. As the frozen main had to be lowered soon on account of proposed street improvement work, they decided to dig up the old line and lower a new one to grade. To offset the cost of trenching in frozen ground was the cost of some kind of temporary relief demanded by the people immediately, the probable scarcity of labor and increased wages, and the loss of revenue for several months.

The thawing of the ground and removal of the old pipe which was 3½ feet deep was accomplished in 17 days. A double line of 1½-inch pipe was laid over the site of the trench and covered to a depth of 6 inches with fine sand. Steam was supplied from a traction engine. The first day a stretch of 180 feet of pipe was laid, but it was found that hot water and steam were returned to the boiler, which showed that we were not using all the heat generated. A little experimenting showed that we could handle a 300-foot stretch at a time. In the morning the shovel gang would throw the sand off the pipe in about 10 minutes and the traction engine would pull the pipe to the next block. Two teams and two men would move the sand and have the pipe covered again by 10 o'clock and the steam would be kept in the pipe until the next morning.

The ground was frozen to a depth of 4½ feet. After applying the heat for 24 hours the ground was clear of all frost for a depth of 2½ feet and very easy to excavate. Below that the frost was so soft that the ground was easily loosened with a pick. The added expense for trenching under such conditions was as follows:

Rent of traction engine per day	$ 3.00
Engineer on day time	5.00
Fireman on during the night	4.50
One ton of coal	8.00
Teams four hours	3.00
Labor four hours	1.50
Twenty laborers 15 minutes	1.85
Sand, and hauling water to boiler	1.50
Total	$20.35

Length of trench opened, 300 feet.

Cost per foot, $0.094.

As soon as the new pipe was laid it was covered with manure, the excavated material having frozen solid, and as fast as the services were connected to the new main they were thawed out by electricity.

ROADS AND PAVEMENTS

Motor Trucks in Public Service

In the reconstruction and emergency work on the good roads system of California during each rainy season the motor truck has proven an important factor. The work accomplished by the California Highway Commission in first-aid work in bridging of swollen streams has opened a new avenue of usefulness for the commercial car.

A fleet of trucks in use by the California Highway Commission has proved that a loaded truck can be sent across pontoon bridges or temporary structures that can be built across streams in a few hours in case the bridge is washed out. In a recent storm the majority of bridges between San Juan Capistrano and Oceanside were carried away by the storm. In this interlying district building material was absolutely unobtainable, as even the railroads were cut off.

Over the deepest washouts temporary bridges were constructed, in many places the truck being driven thru mud hub deep, over ditches and along the bed of a river, distributing material along the route. Large crews of men were worked at different washouts, and they were supplied by the trucks.

Not alone has the truck simplified emergency road construction, but it has reduced cost to a minimum. In the day of the horse-drawn vehicle nearly half of the men's time was spent in going to and from camp. The truck has eliminated these expensive delays, as it also has removed the necessity of many costly camp moves.

CALIFORNIA HIGHWAY COMMISSION'S ROAD-REPAIR GANG WITH MOTOR TRUCK CONSTRUCTING TEMPORARY BRIDGE OVER WASH-OUT IN A STATE ROAD.

TYPES OF WORK REQUIRED AND OF DIFFICULTIES TO BE OVERCOME BY REPAIR GANG AND TRUCK.

ABOVE: PLANKED CROSSING FOR USE UNTIL NEW BRIDGE IS BUILT. NOTE APPROACH TO PLANK ROADWAY ON RIGHT.

BELOW: CONCRETE BRIDGE RUINED BY FLOOD. SOME WORK REQUIRED TO AFFORD TEMPORARY PASSAGE.

Pasadena placed in operation some time ago the first truck of its kind in the world. This car is an aid to the street department and is eliciting high praise from the Pasadena officials who have carefully watched its operation. It does the work of a two-horse and a one-horse outfit. The driver and helper cover 48 miles of street daily, removing every particle of rubbish and sweepings. The refuse is taken to the city parks to be placed in compost heaps and used as fertilizer. At the usual rates paid by orchardists this rubbish would be worth at least 3½ cents a square foot or more than half the cost of collection. The truck is built on a 1½-ton chassis and the body is especially made, being very unique in appearance. It is 9 feet long and 2 feet deep with additional sides 18 inches wide flaring at 45 deg. angle. The truck carries 6 to 8 yards of material at every trip and makes three trips a day

Rated capacity is 165 cubic feet. The tail board is movable as is the interior, and it is of dump type. The chief inspector of Pasadena street department says that the truck is an entire success as a money-saving device.

The city of Los Angeles is the proud possessor of one of the finest garages in the United States. It has been installed for the single purpose of taking care of the automobiles, trucks, motorcycles and engines in city use. Every city machine wanders into this plant at least once or twice a year and gets a complete overhauling.

This garage started on a rather small scale, but rapidly increased as more and more cars were added to the city service. At the present time sixty mechanics are kept busy all the time and hundreds of pieces of apparatus pass thru the shops every year.

The equipment is first class in every respect and is so complete that any kind of work can be done. Fire engines are completely rebuilt from boilers down. Automobiles are reconstructed from the ground up. The speed motorcycles of the city officers are continually on deck, getting small troubles fixed and trying to be patched up after accidents of more or less seriousness.

There are about 180 pieces of apparatus in city use. This includes fire engines, police machines, ambulances, trucks and motorcycles. All of these machines are repaired in the city garage. The several departments represented in the list are fire, police, health, hospital, park, engineering, humane and municipal market.

Efficient Haulage With "Road Train"

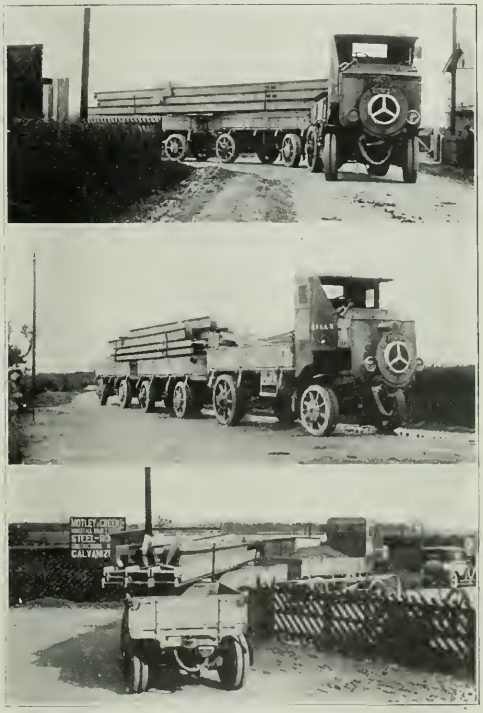
One of the most recent developments along the lines of low-cost haulage is the Armstrong-Whitworth road train as now used to a considerable extent in France and England. While this train has all of the valuable features of the older style train, which consisted of a tractor or truck pulling a train of loaded wagons, it also has merits which could not possibly be attained with the use of a single pulling unit. Chief among these is the ability of the Armstrong-Whitworth train to go backward as easily as forward, taking corners in the track of the leading truck. As traction is furnished to the wheels of each one of the trailers, the effective pull and adhesion to the roadbed is much greater than could be expected where all of the tractive effort came from the two or even four wheels of one truck or tractor.

While several mechanical and electrical trains have been devised from time to time, none of these have been entirely free from faults which prevented, or at least impaired, their success. A number of the purely mechanical trains depended on a more or less complicated arrangement of driving shafts and universal joints, which carried the engine power from the truck, applying it to one after the other of the trailers. Because of the multiplication of bearings, spring drives and transmission, and also because of starting and braking difficulties, this variety was doomed to an early failure.

In a general way, the "all electrical" trains were an improvement, yet left much to be desired. Fundamental in this scheme was the use of a powerful engine-driven dynamo, which supplied current to motors not only in all of the trailers, but in the tractor as well. While the starting difficulties were overcome, and there would naturally be a wide latitude in the matter of speeds, the apparatus was somewhat cumbersome, and due to unavoidable electrical losses was not highly economical.

With the combination of the electrical and mechanical systems in the Armstrong-Whitworth train, the difficulties inherent in both "unmixed" drives seem to have been eliminated. Power is supplied direct to the tractor by the gas engine. A dynamo of moderate size generates power for all of the trailers, each of which is motor-equipped. On starting, when a heavy pull is demanded, electric power is transmitted all along the train, and each trailer does its part in supplying tractive pull to set the train in motion. As the trucks come up to their normal speed the auxiliary motors are cut out, and what work is necessary to keep the loads moving at ordinary speed is taken care of by the engine alone. Where heavy grades or rough roads are encountered, the trailer motors can instantly be set to work by the driver.

As a result of the efficiency obtained by the elimination of many of the electrical and mechanical losses, it is claimed that remarkable fuel economy is obtained by the Armstrong-Whitworth train. Tests conducted with a 30-ton load showed that 77 ton-miles were made to each gallon of gasoline. This was on a non-stop run of 210 miles, over wet roads.



GAS-ELECTRIC ROAD TRAIN TURNING CORNER WITH 27½-TON LOAD OF GIRDERS.

ROAD TRAIN ON THE "STRAIGHT-AWAY" WITH 30-TON LOAD; 5 TONS ON TRACTOR AND 25 TONS ON TRAILERS.

LOADED ROAD TRAIN BACKING AROUND SHARP CORNER.

A feature which is of considerable importance and which could hardly be obtained in any train other than an electrical one, is that which permits operation of a trailer separate from the tractor. By the simple expedient of attaching a long transmission cable to carry current from the truck generator to the trailer motor, the trailer (controlled by a driver) can be operated over a range of several hundred feet quite independent of the movement of the tractor itself. This allows a train to be taken in sections over a weak bridge or thru a very bad stretch of road where handling the entire train would be a difficult matter.

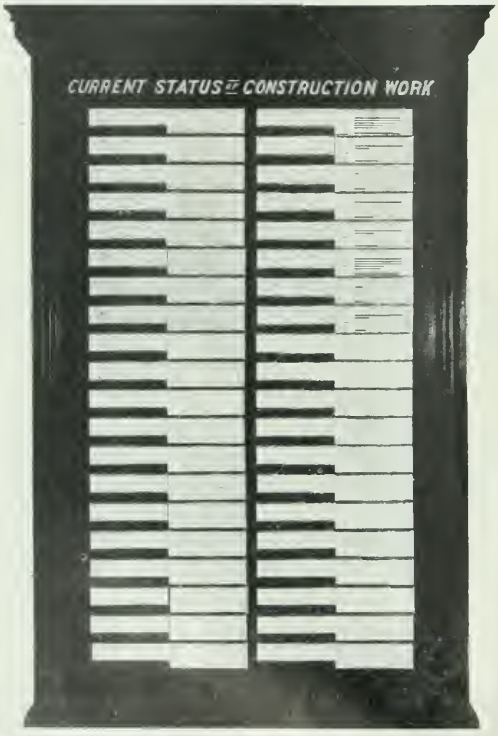
Electric lighting and electric brakes are features of the new train. The tractor motor is self-starting.

Planning Board for City Work

In order that the chief engineer and his assistants and subordinates may at all times be informed on every phase of construction work, either contemplated or in progress, the Philadelphia Bureau of Highways makes use of an unusually complete planning board. As applied to the Philadelphia highway problems, this board eliminates almost entirely the necessity for constant reference to office records, and presents all facts graphically in such a way that they are instantly and easily grasped.

As worked out by Mr. Wm. H. Connell, chief of the bureau, the system includes not only the boards, but current status records, indicators and daily progress reports. Of the current status record two forms are used, one for contract work and one for municipal work. This is for the chief engineer. Another form in three parts is used by the district assistant engineer. These forms give all necessary facts regarding the current status of work authorized, under contract and under way.

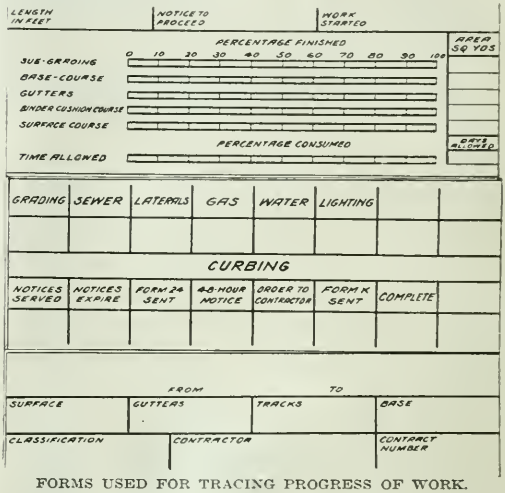
The planning board itself consists of a framed map showing the district involved. For the chief engineer this field is the entire city, while for each assistant only the portion over which he has direct charge is included. In each case the scale is sufficiently large to show all details plainly. For the chief engineer and the division engineers, a scale of 1,000 feet to the inch has been adopted, while for the assistant division engineers the more detailed proportion of 500 feet to the inch is selected. This gives the assistant division engineers a record of all work down to the most minute detail.



PHILADELPHIA'S PLANNING BOARD.

Colors applied to and shown on these maps indicate the kind of pavement. If more than one material is used on a street, the fact is indicated by the proper tints. Maintenance guarantees covering certain sections of paving are indicated by a penciled cross-hatching which readily can be erased on expiration of the guarantee period. Plain blank tints are used to indicate the existence of street railway lines.

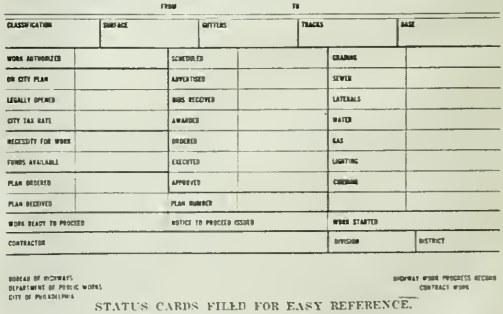
For recording permanent information, a series of specially colored and labeled flat-headed tacks are used. These tacks



FORMS USED FOR TRACING PROGRESS OF WORK.

These tacks by their appearance tell the observer at a glance some vital fact about conditions at the various points where they are inserted. Further reference is given by numbers imprinted on the tack heads, these numbers referring to numbered cards, on which is detailed all information about the point in question. Information of temporary value is given by colored glass-headed pins of varying sizes.

In order to fix responsibility for the proper "posting" of information, each board is supervised by a single employe, whose duty it is to see that all changes are made promptly and that the information recorded is at all times accurate. This posting is done at the beginning of each working day from reports turned in by inspectors and engineers.



STATUS CARDS FILED FOR EASY REFERENCE.

Daily data on each job is sent in to division engineers. This is in addition to the detailed construction report that goes to the district assistant engineers. These "progress reports," as the daily postcard reports are called, indicate detailed facts as to the force employed, weather conditions, temperature and other necessary facts. These cards are then filed in alphabetical order in the division engineer's office.

Paving Street Railway Tracks

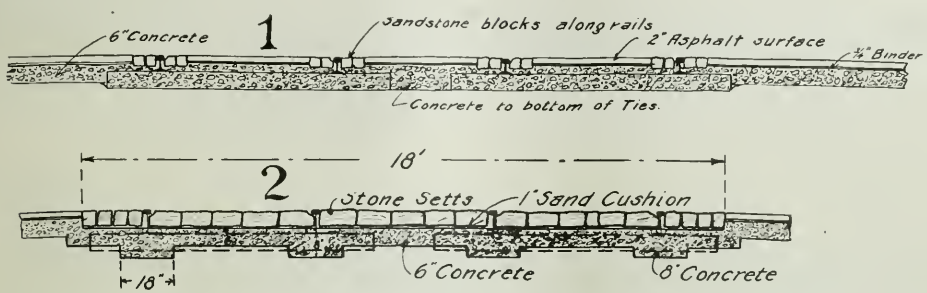
There is probably no other public utility which has undergone a greater evolution in the last twenty years than the street railway. During the last few years of development the cars that were used averaged about five tons in weight, and the pavement in the track areas was designed accordingly.

In the past few years the development has been extremely rapid and the weight of the cars has jumped from ten tons to the double-trolley twenty-five-ton cars which are today used in Ottawa.

The writer intends to give in this article details of the various kinds of pavements constructed in Ottawa on the street railway area, showing the evolution from the time the pavement was designed to stand the five-ton car.

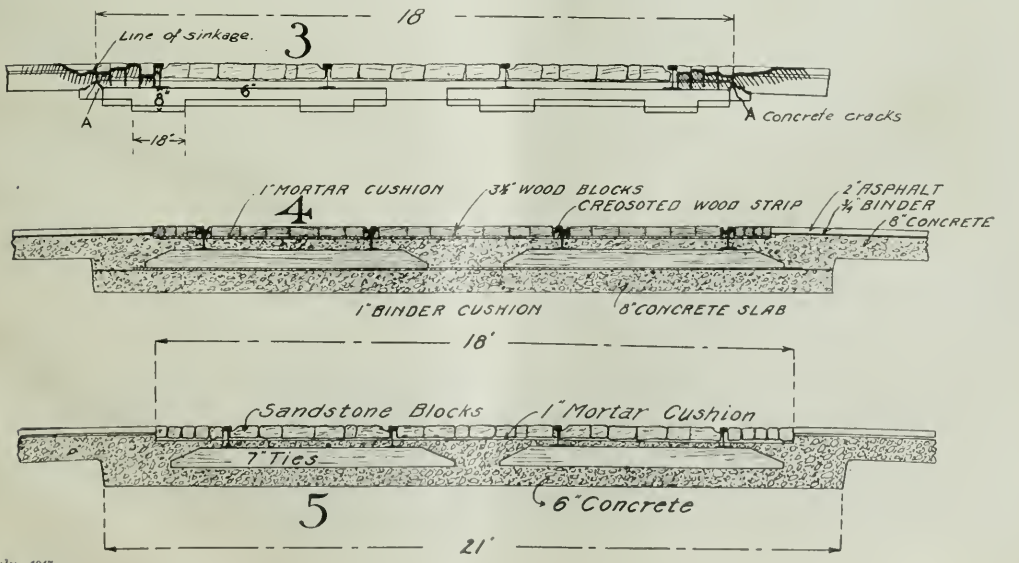
Fig. 1. shows the type of pavement which was first constructed in Ottawa in the tracks allowance; this was about twenty years ago, and happily only two streets were laid in this manner. Before these streets were repaved the whole track area had deteriorated due to the vibration of the heavy street cars. The two sandstone blocks that were laid in the manner next to the rails had sunk about six inches and the asphalt between the blocks was so badly cracked that passing vehicles striking the rails or blocks with their wheels lifted sheets of the asphalt. Before the debenture period had expired the city had spent enough money on repairs to construct a new pavement.

Fig. 2 shows the next style of pavement tried in the track area. It will be noticed an extra body of concrete was placed under the rail 18 inches in width by 18 inches in depth (from the web of the rail). This type was discarded in 1912 owing to several weaknesses which developed within two years of the pavements being constructed. The principal weakness developed in the two outside blocks next to the asphalt and also for about 12 inches on the asphalt next the blocks. Fig. 3 shows how the pavement deteriorated. It will be observed that the two margin blocks began to sink an appreciable distance below the rail, the asphalt following suit. This was due entirely to the foundation not being strong enough to support the heavy city and interurban cars. The vibration of these cars shook and cracked the concrete at the end of the wood ties as shown in Fig. 3 at the point marked "A." The vibration continued until the concrete crumbled away under the blocks, with the result as stated above.



In 1914 the type of construction for the track allowance was radically changed from former types. Bank street, one of the main business thorofares, was to be repaired and it was done as shown in Fig. 4. An 8-inch concrete slab was first laid 21 feet wide. On the top of this slab was laid a one-inch cushion of asphalt macadam for the ties to rest upon, (this cushion greatly reducing the noise of the cars).

The writer had the railway company bevel the ends of the ties as shown on the section. This was tried as an experiment to do away with the sinking of the outside blocks—a bad fea-



ture of former pavements as already explained. It will be seen that with the beveled ties a much heavier body of concrete is between the outside blocks and the ties, thereby preventing any chance cracking and crumbling of concrete by the vibration of passing cars. Wood blocks were used to pave this track allowance.

The practice of laying the concrete slab first has since been done away with, as we had trouble with the ties, in setting the rails to grade. These ties were supposed to be 6 inches in depth, but in reality ran between 6 and 7 inches, with the result that we had to place steel wedges under them when bringing the track to grade.

Fig. 5 shows the method of construction used in 1915 and 1916 on tracked streets where the traffic is fairly heavy. The concrete is shown as being one solid mass. The rails were suspended and the concrete poured, thus obviating the trouble we had in the case of Bank street. Sandstone blocks were used to pave the track area.

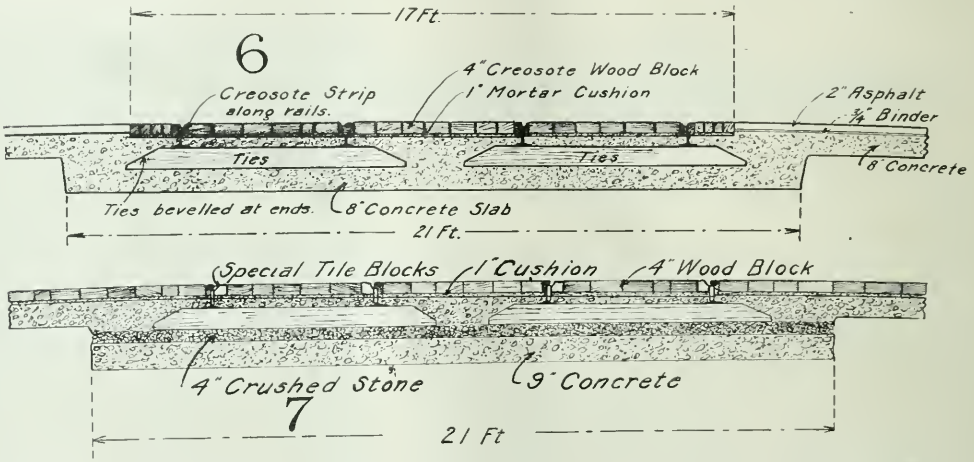


Fig 6 shows a section of the track allowance on Rideau street, which was constructed this year. This is practically the same construction as shown in Fig. 5, with the difference that the depth of concrete under ties was increased to 8 inches and wood blocks were used instead of sandstone. An extra block was added to the margin to bring them beyond the edge of the ties, doing away with any chance of vibration which would cause the asphalt to crack.

In the Rideau street pavement a change was made in the construction where the railway company's special work was laid. Instead of the rigid usual construction in straight track work, the concrete slab was laid first to a depth of 9 inches. On this was laid a 4-inch covering of 2-inch stone, upon which the ties were laid as shown in Fig. 7. This allows greater flexibility and also allows the special work to be renewed without disturbing the concrete slab. All pavement in the special-work area will be constructed in this manner in future.

Fond Du Lac's Trucks Save Money

A report submitted by Chief Dolly of Fond du Lac, Wis., proves that a considerable saving resulted from the use of motor fire apparatus by that city in place of the horse-drawn trucks. Carefully compiled figures showed that the expense of operating the motor trucks thru a three-year period was $672.52 while the expense of a two-horse fire truck for the same period was $1,083.95.

Keep on Building.

At no period in our history have we been so sure of the future. The western world's stomach is feeling the pinch of hunger, and its demands on the products of America's broad acres and American industries are growing with every passing hour. A great market is opening wider and wider. Honest and fair profits in all lines of legitimate effort are certain.

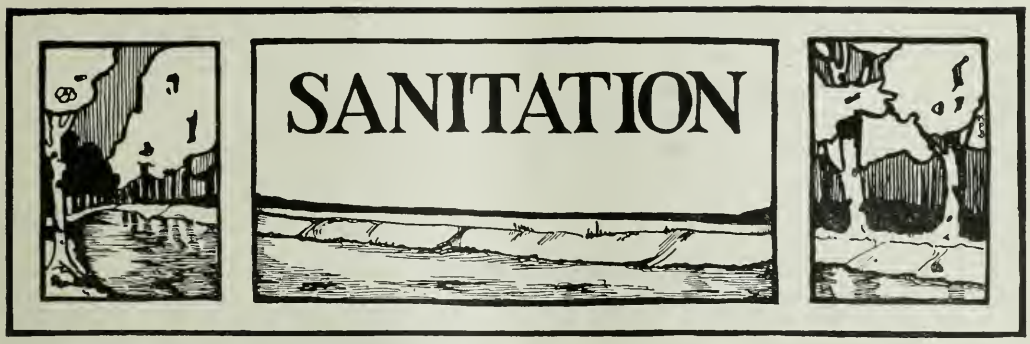
There should be no curtailment in building and road construction. Let both public and private useful construction proceed. Production and handling of building materials and public and private construction work are fundamental industries of the country. Any tendency to suspend or postpone building projects is inconsistent with maintaining our prosperity. The country is prosperous. Building investors should not hesitate to go ahead with their plans. Railroads should spare no effort to supply the building industry with the cars needed to transport materials. Government, state, county and municipal authorities should encourage the continuance of all kinds of building. Road and street improvements in particular should go on unabated. Bad roads and streets are factors of first importance in the present high cost of foodstuffs. Never before was the improvement of highways so essential.

Will Make Wire-Cut Lug Brick.

The Brick, Terra Cotta and Tile Company, of Corning, N. Y., Mr. M. E. Gregory, proprietor, has become a licensee of the Dunn Wire-Cut Lug Brick Company, of Conneaut, Ohio, and will engage in the manufacture of wire-cut lug paving brick. This company is one of the most important paving brick concerns in that section of the country, and it is widely known for the quality of its product and the reliability of its business methods. Mr. Gregory, the proprietor, is one of the leading business men of that section.

Higgins Road Contract

Contract for the Higgins Road, commencing at a point six miles from Chicago's city limits, and ending at the county line, a distance of 18½ miles, has been awarded to the Commonwealth Improvement Company, of Chicago. They have placed a sub-contract for a narrow-gage railway for handling of the aggregate, with the Orenstein-Arthur Koppel Company, of Chicago. This railroad consists of 8½ miles of Koppel portable track, the necessary Koppel dump cars, etc.



Novel Sewer-Cleaning Device

The accompanying illustrations show a recently perfected machine designed for sewer cleaning from the street surface and eliminating many of the disagreeable features of old-fashioned interior work.

The device consists of two 4-wheeled trucks placed at two successive manhole openings and a special steel bucket which is pulled between the manholes by means of a cable. One end of the cable is attached to a hand-winch on one truck, and the other end to a similar winch on the other. The bucket is not necessarily drawn from one manhole to the next, but is drawn into the sewer only far enough to be filled with the deposit and then pulled out of the same manhole in which it was inserted.

This is made possible by the peculiar construction of the bucket, which has two hinged scoops at one end so arranged as to close up tightly as soon as the reverse pull is made, and also to expand the bucket as it is emptied. Four guard-plates are riveted to the sides of the bucket to prevent excessive wear and they constitute a hinge for the jaws. The edges of the scoop are finely sharpened to cut any roots or growths that may be located in the sewer bottom.

One noteworthy feature of the apparatus is the means whereby the full bucket is lifted out of the manhole without the cable cutting into the sewer or manhole brickwork. This is effected by a guide-jack, consisting of a yoke with ball-joint adjusting screws at one end, and a wedge connection on the other end. This is lowered into the manhole on chains hooked to the manhole-rim, and carries a pivoted arm with a cable pulley. When the bucket is being taken out, it strikes the arm, revolving it upward about its pivot, so that the bucket is guided free out of the sewer-tile and then up the center of the manhole without obstruction.

The sharpened jaws scrape the tile thoroly, so that every particle of debris is removed. When shut, they are so tight that nothing in the bucket can escape.

TROLLEY-JACK AS USED IN PULLING EXPANSION BUCKET THRU SEWER. WHEN THE REVERSE PULL IS MADE ON THE CABLE THE JAWS OF THE BUCKET CLOSE AUTOMATICALLY SO THAT NOTHING CAN ESCAPE EXCEPT THE EXCESS WATER, FOR WHICH SPACE IS PROVIDED ALONG THE SIDES OF THE BUCKET.

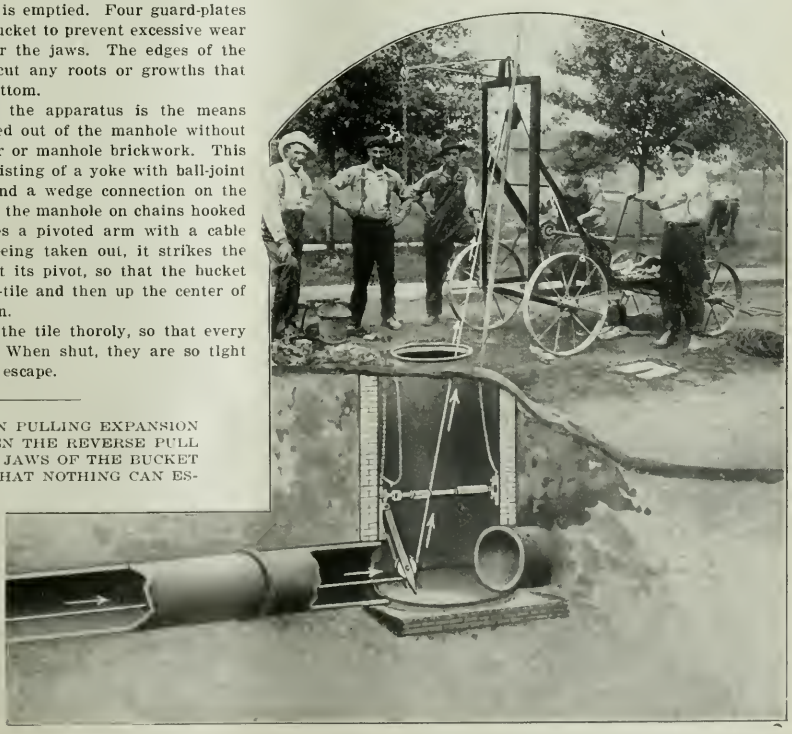
Courtesy of "Popular Mechanics."

Low Cost Water Main Cleaning

Very little skilled labor is needed for the work of cleaning water mains when a recently perfected flexible-joint cleaner is put on the job. Aside from the superintendent and the foreman in charge of the work, the only highly paid man required is a single calker. In connection with work as done at Hartford, Conn., fourteen laborers were kept busy, one team also being required to haul material and supplies.

The machine itself is made up of three distinct sections held together by a central flexible-joint shaft. This joint arrangement allows the machine to pass around any curve of moderately long radius. Cutting is done by the first section which is made up of three spiders fastened to the shaft, all these spiders being provided with saw tooth blades. Even the hardest incrustations and scale are torn loose by these blades.

In the second section there are two spiders both armed



with smooth scrapers. Whatever material is left after the passage of the sawtooth scrapers is taken off by these smooth blades.

Both of these sections are propelled thru the pipe by the force of the water back of the cleaner. The water in the pipe presses directly on a double piston which fits very closely into the pipe. Leather gaskets pressed outward against the pipe make the piston practically water-tight. Dampers set into the piston allow sufficient water to pass the device to wash away the scale and slime that is detached from the pipe. Metal deflectors set loosely on the shaft serve to turn the flow of water against the pipe walls and keep the loosened materials well ahead of the cleaner. A double row of scrapers follows after the machine, these scrapers barely touching the pipe surface and taking any residue off so that a clean, smooth pipe is assured.

VIEWS SHOWING STREAMS THROWN BEFORE AND AFTER CLEANING OF WATER MAIN.

Thru the use of this piece of apparatus a large number of pipes that have become inefficient thru the accumulation of sediment have been restored to the same high efficiency level that they possessed when first installed. In some cities pipe systems that had not been cleaned for twenty-five years, and had lost a considerable percentage of their carrying capacity thru the deposit of slime and scale and thru growth of various organisms, were entirely restored.

As an instance of "before and after" efficiency, a test made in Brooklyn, N. Y., may be cited. Flow measurements were taken on 950 feet of 12-inch pipe which discharged thru an open end on the street. Before cleaning, this pipe carried 1,235 gallons per minute. After cleaning, with all other conditions the same as in the former measurement, the flow was 3,754 gallons per minute. These figures showed an actual discharge increase of 204 per cent. In addition the frictional loss of 98 feet before cleaning fell to 69 feet afterwards, with much greater flow. Taking both items into account, the carrying capacity of the pipe was increased by cleaning some 265 per cent.

A test made on a 6-inch pipe at Perth Amboy, N. J., in which the iron rust incrustation was exceedingly light (⅛ inch to ¼ inch) showed after cleaning an increase in discharge of 32 per cent. and an increase of 51 per cent. in carrying capacity.

To cite another instance: At Belle Plain, Iowa, there was a frictional loss of 39.8 feet per 1,000 feet of pipe before the cleaning was done. Afterward this fell to 9.7 feet per 1,000 feet. In another case a gain of 135 per cent. was shown.

Water mains at Mt. Vernon, Ill., became so dirty at one time that a full 60-pound pressure had to be maintained at the pumping station to show the required 20 pounds at the city office during the heavy draught hours. In addition to this difficulty the fire streams were very poor; water was muddy, and the cost of pumping was far too high. With clean pipes from which the slime and scale had been taken by the device illustrated, the average pressure at the pumping station was cut down by 20 pounds, and even with that decrease a higher pressure than before was maintained in the mains. A reduction of 27.7 per cent. was made in the power required to operate the pumps.

Electric Pumping in Michigan

Difficult problems which arise in connection with deep-well pumping of water for municipal use have been successfully overcome in the electric pumping system operated by the village of Richmond, Mich. These obstacles in the way of an adequate water supply are well recognized and are a direct result of the inability which frequently exists of locating wells near enough together to permit the efficient operation of steam pumps from one boiler. It has often happened that six or eight deep wells have been sunk before an adequate water supply has been obtained, the expenditure being followed by a discovery that the wells were too widely separated to be efficiently operated.

Under the head of "Deep Wells," as commonly used, fall all wells in which the water does not rise to the suction level. To these in general electric power can be applied with great economy. Two methods of deep well pumping are in common use, these being by the plunger lift principle and by the application of compressed air. The former principle is applied in the case of the plant described.

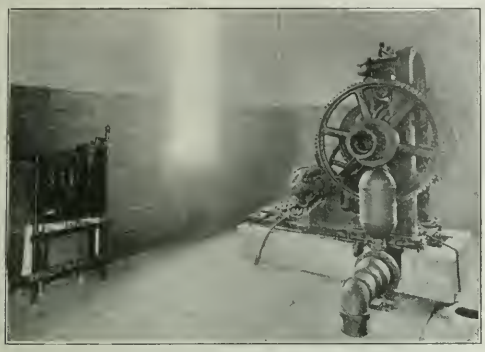
Water for the village of Richmond is obtained from three deep wells, two of which have 12-inch and the third 8-inch casing. All three are 131 feet in depth, and are ordinarily filled to within about 95 feet of the surface of the earth when the pumps are in operation. This water level is higher by about 30 feet when all pumps are stopped for a period. The three wells are located about 100 feet from the water works plant, and are so near together that they were for a time operated by standard steam deep-well heads. These were American Well Works vertical pumping heads, single acting, with a capacity of 200 g.p.m.

As a beginning of the change from steam to electrical operation a motor-driven head was installed for the steam head on one of the 12-inch wells, the pumping speed being increased to make up for a shorter working stroke, and the pump capacity thus being held the same. With a 24-inch stroke instead of the former 36-inch stroke, the pumps were speeded to 25 strokes per minute to maintain the 200-g.p.m. capacity.

Power for operation of the changed-over well is supplied by a 25-h.p. General Electric slip-ring induction motor, taking power from a 3-phase 220-volt circuit. While a somewhat smaller motor would have been adequate for the immediate needs of the plant, the size chosen will prove economical, as it will permit the use of considerably larger working barrel with no change in the power end. Means for automatically starting the pumping motor consists of a water-pressure governor, which works in conjunction with an automatic contactor panel.

At the second of the 12-inch wells, water is lifted by a Luitweiler double-acting pump head; capacity, 200 g.p.m. Here power is supplied by a 15-h.p. slip-ring induction motor. In this type of head cams are used instead of cranks, and the pistons working in the same barrel give a continuous flow of water. The motor is geared to the cam shaft, practically all gear noise being eliminated by the use of a rawhide pinion on the motor.

While both of the pumps are used during the summer months, when the afternoon sprinkling period calls all equipment into service, the work is at other times divided so that the automatic head is used only for night work. Provision is made at the switchboard and by means of transformer connection, for uninterrupted service even in case of partial failure of the electrical equipment.



LUITWEILER DEEP WELL PUMP.

In order that the village may not be absolutely dependent on the electric supply, the 8-inch well is still equipped with one of the original steam pump heads.

With the three units the daily production of the plant averages about 130,000 gallons, all of this water being pumped into a reservoir approximately 100 feet above the pumps. The high all-year water consumption at this plant is partially accounted for by the fact that the railroad obtains its local water supply from the city, using about 50 per cent. of the total amount pumped.

For fire use, two high-pressure service pumps have been installed. One of these is a 14x8½x12-inch steam fire pump for emergency service. The other is a DeLaval 1,600 g.p.m. 2-stage centrifugal pump, direct connected to a 3-phase 2,300-volt 1-700-r.p.m. motor. Suction of this unit is connected to the reservoir and, discharged, goes directly into the mains, so that a pressure of 80 pounds is easily maintained.

A high and low-pressure alarm gage is connected to sound an alarm in the attendant's house.

Figures given by the electric company, which concern supplies electric power for the operation of the Richmond and numerous other Michigan pumping stations, bring out a number of interesting facts regarding steam and electric pumping.

Figures are as follows:

LUITWEILER PUMP (ELECTRIC).

Speed	Static Head	G.P.M.	Efficiency
½	180 feet	96	39.6%
¾	180 feet	144	51.3%
Full	180 feet	208	66.1%

AMERICAN PUMP (ELECTRIC).

Speed	Static Head	G.P.M.	Efficiency
½	180 feet	80	42.2%
¾	180 feet	131	52.2%
Full	180 feet	192	63.4%

AMERICAN PUMP (STEAM).

Speed	Static Head	G.P.M.	Efficiency
Full	185 feet	145	23.5%

More detailed figures taken from the plant in the village of Richmond, to which the company sells power, show actual costs where three methods of pumping are carried on under the same conditions, and hence are subject to direct comparison.

PUMPING COSTS AT RICHMOND.

	Deep Well (Electric)	Deep Well (Steam)	Centrifugal (Electric)
Gal. pumped per day	124,031	146,750	14,484
Gal. pumped per kw. hr.	760	.....	1,282
Revenue per 1,000 gal.	$0.035	$0.035	$0.56
Revenue per kw. hr.	$0.026	.....	$0.071
Gal. pumped per lb. of coal	.....	39	.....
Revenue per h.p. hr.	.....	$0.0102	.....

Septic Tank for Small Plants

Suburban communities—particularly prior to the development of regular municipal sewage disposal systems—are very likely to have difficulty in disposing of household refuse properly. The customary method of meeting this contingency is by installing a brick or concrete septic tank underground some distance from the house. This practice, of course, necessitates running the soil pipe at a depth below the frost line. Oftentimes this, together with the loss occasioned by the tank connection, renders it impracticable to take out the discharge pipe at a tank level which will permit the fluid discharging effectively into the final distributing system.

This difficulty is said to be adequately overcome by the Andrews septic tank. The system, in its case, consists essentially of a single 2-chambered tank made of ¼-inch steel plate, with riveted heads and manholes. It is air-tight. Ventilation and gas escapage are effected thru a pipe to the air, thus making it possible to give the tank either a building-basement or outside-surface setting.

A specially-designed cast-iron intake-fitting is securely stud-bolted to the head of the tank, discharge below the scum, and also a cast-iron discharge-siphon fitting of special shape. This latter fitting is a portion of the special discharge apparatus which automatically empties the tank as fast as it fills.

The tank itself is divided into two compartments, all waste being received thru the intake fitting on one side. When this compartment is filled, the contents in turn empty automatically about every 12 or 14 hours by means of a patented siphon discharge-pipe. Both the outlet and inlet are so placed that the contents are maintained in the quiescent state requisite for effective septic action and precipitation.

After discharge from the septic tank, the fluid is carried via soil pipes into a 4-inch sewer pipe, from which lateral branches of 2-inch drain tiles, laid with the joints open about ⅜ inch, are taken. These branches are made from "Y's," assuring an unimpeded flow of nearly equal density over the entire surface of the field. The character of the soil must be of loose, light nature. If it is not, a specially-prepared filter bed must be made.

The above-ground setting of the tank in this system enables the tile and filter-bed to be arranged quite close to the surface, and this feature is of real importance in solving the problem of disposal in wet soils, inasmuch as a special filter-bed can be made of cinders, sand or some other porous material.

In practice, it is claimed that this Andrews system is odorless and not subject to freezing. It is further said that it is necessary to clean out only about two pails of sludge per year.

WORKERS IN THE FIELD

Laying 48-Inch Main Across River

The Editor of MUNICIPAL ENGINEERING:

Sir—After overcoming unusual obstacles, due to an excessive amount of water in the land excavation and to the swift current of the Allegheny river, the immense 48-inch riveted steel water main being laid across that stream from River avenue, on the north side of Pittsburgh, Pa., to Twenty-sixth street, on the south bank, in the old city, is practically completed. All in all, there are in this contract approximately 1,150 feet of pipe, connecting a supply main leading from the new north side municipal reservoir on Cabbage Hill, completed and put into service November last, to Twenty-sixth street and Liberty street. This main is to help supply the lower portion or downtown business section of the city, and parts of the lowlands of the south side and west end of the city. The contract for the furnishing and laying of the pipe in the river was awarded to the T. A. Gillespie Company, of Pittsburgh and New York City, work having been started June 23 last, the contract calling for the completion of the job within six months.

The line crosses the river about two squares above the government lock and dam at Herr's Island, and between the bridge crossings of the Pittsburgh junction railroad at Thirty-third street, and that of the Pennsylvania Lines West, or Pittsburgh, Fort Wayne and Chicago railroad, at Eleventh street.

Four Divers Constantly Employed.

The chief difficulty caused by the current was the maintenance of the excavation and the holding of the pipe in place, work calling for unusual exertions on the part of the divers. The latter had the unpleasant experience of having to work in river slime at the Twenty-sixth street end of the line, owing to the fact that the Twenty-sixth street sewer discharged within 20 feet of the pipe line. Two diving outfits were used, four divers being constantly employed on this phase of the work.

The pipe was loaded on an ordinary Allegheny river barge in 30-foot sections and riveted up there in 120-foot pieces, with a flange at each end. The barge was 160 feet in length. Dead caps were placed on either end of the line, and the pipe joints tested at the specified pressure of 300 pounds to the square inch. Then the water in the pipes was released, the valves closed and the pipe rolled into the water. The laying of the pipes was effected by driving 4-pile bucks at each flange, the line being swung into place by floating under the bucks, slings being placed around the line at each buck. The valves being opened, the water entered the pipe, causing it to gradually sink and become embedded upon the bottom of the trench in the bed of the river. The pipe is of $\frac{3}{4}$-inch steel. The flanges have $\frac{1}{8}$-inch lead gaskets, and are bolted by 44 $\frac{1}{2}$-inch bolts.

The submarine trench is 10 feet wide at the bottom, the latter being 26 feet below the surface of the river at normal stage. The depth of the trench varies from 10 to 25 feet. So strong was the current at times that it was impossible to hold the pipe steady at some joints, the pipe being swept clear out of the ditch. From two to three days were required to

PITTSBURGH WATER MAIN, READY TO BE ROLLED ON BARGES.

FLOATING 48-INCH PIPE UNDER BUCK, PREPARATORY TO SINKING.

DERRICK BOAT AT WORK LAYING PITTSBURGH WATER MAIN.

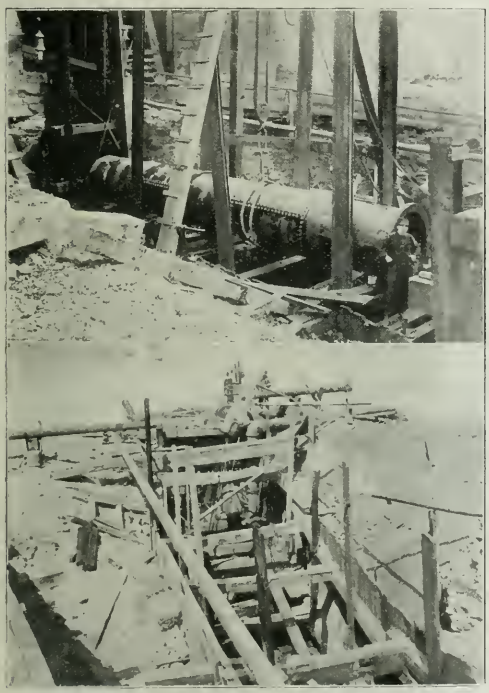
connect up each flange, which under normal circumstances could have been done in ten hours.

The river bottom at this locality consists of sand and gravel.

Machinery Employed.

Two derrick boats, equipped with clam shells, and one dipper dredge were used. Some old wreckage in the shape of iron bridge beams—presumably the grim reminder of some catastrophe or mishap of the past—had to be removed.

A pump chamber, 6x6 feet, the walls of which were ⅝-inch steel plates, was constructed on the old Pittsburgh side of the river, the stream being coffered off with Lackawanna steel sheet piling. This chamber was surrounded with a heavily reinforced 18-inch concrete covering, the reinforcement comprising 1-inch twisted steel rods. Contrary to expectations, heavy water was met with on the land side of the



CLOSE-UP VIEW OF 48-INCH PITTSBURGH WATER MAIN AT WELL.

SECTION OF THE 48-INCH WATER MAIN AT POINT ON THE SOUTH BANK OF THE ALLEGHENY RIVER.

excavation, and it was found necessary to pump 5,000 gallons a minute continuously for over three months. The water boiled up with such force from the bottom of the chamber that it was difficult for the men to maintain a foothold, or, in fact, do their work. The chamber was finished October 22.

The work was done under the supervision of the Bureau of Water, department of public works of the city, Charles A. Finley being superintendent of the bureau.

Requirements of Specifications.

The specifications provided that the steel for plates should bend cold, 180 degrees, or "double flat," when hammered, without showing the least sign of fracture, and should withstand the same test after having been heated to a dull red heat and quenched in cold water.

The tensile strength for plates was placed between the limits of 55,000 and 65,000 pounds per square inch, with an elastic limit of not less than 50 per cent. of the ultimate strength, and an elongation of not less than 25 per cent. in 8 inches, longitudinally of the plate, with a reduction of area of not less than 45 per cent. at the point of fracture of longitudinal sample, which fracture was required to be silky in character.

The steel used in making rivets was required to have a tensile strength between the limits of 45,000 and 55,000 pounds per square inch, an elastic limit of not less than 50 per cent. of the ultimate tensile strength, and an elongation of not less than 27 per cent. in a test bar of 8 inches long. They were to stand bending 180 degrees, or "double flat," both before and after heating to a cherry red and quenching in cold water, without signs of fracture on the convex surface of the bend.

HARTLEY M. PHELPS,
209 S. Neville St.,
Pittsburgh, Pa.

Chicago's Municipal Steam Turbine Pumps

The Editor of MUNICIPAL ENGINEERING:

Sir—The accompanying illustration shows the steam turbine pumps at the Lakeview water works pumping station at Chicago, Ill. Each turbo pumping unit consists of a 20,000,000-gallon centrifugal turbo pump driven by a 600-h.p. steam turbine at 120 feet head with 145 pounds working pressure and 28-inch vacuum. There are also in operation two 75-k.w. d.c. turbo generator sets and four 800-h.p. steam turbines, all designed at Wellsville, N. Y.

It is generally agreed that the pumping sets has many advantages in either the direct-connected form or with herringbone reduction gears. It is pointed out that a few years ago when the only high duty pumping units available were of delicate construction and high speed, engineers turned to motor-driven pumps as a simple and good means for water supply. Within recent years, however, turbine-driven pumps are being more generally used than motor-driven pumps, largely because operating men prefer units which draw their power direct from the boiler at very good steam rate, rather than units which must get their power thru generator, transmission line and motor.

Steam turbine engineers claim that in making a comparison, fairness demands that the generating capacity necessary to operate the pump motor be charged against the electrically-driven outfit. This alone will be something like $25 per k.w., and for an average sized pump brings the initial cost of an electrically-driven unit to almost double that for a turbine unit. In the case of a non-condensing turbine-driven pump, the thermal efficiency of the unit, when exhaust steam is used in the feed water heater, will be in the neighborhood of 95 per cent.

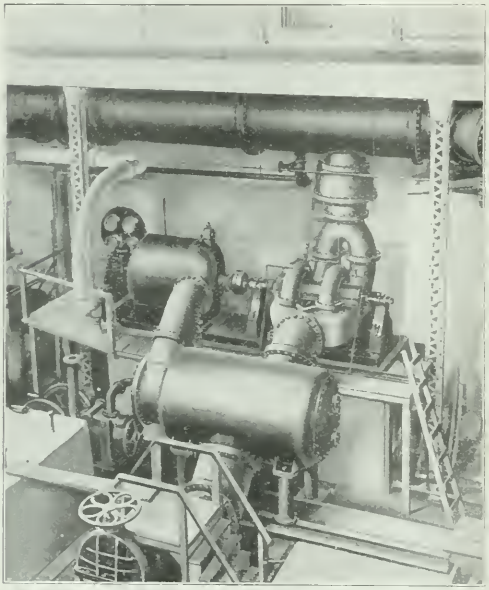
It is held that compared with this, the thermal efficiency of a motor-driven centrifugal pumping unit is actually only about 15 per cent., taking into account all losses in the electric generator and the driving motor. This large difference is due to the simple fact that the exhaust steam of the turbine can be put directly into a feed water heater without fear of danger from oil to the tubes of the heater or to the boiler, according to the type of feed water heater used.

It is urged that when pumps or other auxiliaries are driven by a steam turbine, all the heat excepting that slight amount lost by radiation which it does not convert into useful work is returned to the boiler. Many engineers held that all auxiliaries should be steam-driven, so that the exhaust may be used for a feed water heater. In this way the auxiliaries may operate at about 80 per cent. thermal efficiency. Should the pump drop off in efficiency, the motor is liable to be badly overloaded in obtaining the same amount of water. A steam tur-

bine, on the other hand, is designed to carry large overloads, and when fitted with an overload type, the turbine easily carries one and one-fourth times the rated load.

Speeded to Accurate Control.

It is undoubtedly true that a most important advantage of the turbo pump lies in its ability to be speeded to accurate control. Speed change which controls the quantity or head is very easy, although practically impossible with an alternating current motor. Water supply and head are seldom exactly constant, so the importance of this advantage is clear. There are instances where alternating current motors have been installed, and, due to some slight change, have become totally unsuited for their work. As an example: A prominent rubber company installed a motor-driven pump to deliver 1,000 gallons per minute under 80-foot head. Later this firm wished



STEAM TURBINE PUMP FOR CHICAGO STATION.

to increase pressure in the plant and operate the pump at 80 pounds. This was impossible with the motor whose speed was limited to 1,800 r.p.m., as it was an a.c. 60-cycle motor; but by substituting a steam turbine and speeding the pump up from 1,800 to 2,600 r.p.m., the desired pressure was obtained.

Have Demonstrated Reliability.

It is of interest to note that the turbine-driven centrifugal pumps as standby units in water works service were advocated in Europe as early as 1905, and installations abroad and in this country have now demonstrated reliability and ultimate dollars and cents economies, fully as good as from the best triple expansion units, both in standby and constant service installations.

It is held that the demand on one pumping station in this country involves 60 per cent. of capacity 295 days per year, 60 to 80 per cent. of capacity 48 days per year and 80 to 100 per cent. of capacity 23 days per year. In other words, 40 per cent. of the plant is not needed 295 days per year, a figure broadly right for the average plant.

There is a 7,200,000-gallon turbine-driven water works pump installed by the city of Youngstown, Ohio. The pressure head is 90 to 110 pounds and the speed 1,600 r.p.m. Under test, the duty obtained was 11.2 per cent. better than the guaranteee of 80,000,000 foot-pounds per 1,000 pounds of dry steam. The city of Youngstown also purchased a triple expansion reciprocating pump for the same conditions, except that the duty guarantee was 163,000,000 foot-pounds. The cost of the turbo pump was about $10,000 and operating costs $9,400 per year, as against $72,000 and $14,000, respectively, for the reciprocating pump.

A modern steam turbo pump requires to carry excess over the 60 per cent. to carry the peaks, to quickly increase pressure and quantity output for fires or to operate during temporary shutdowns of a main unit, just about one-fourth as much of an investment as for a reciprocating pump, foundation and buildings to provide equal capacity increase. In standby units, even where the price of coal is high, and if the steam consumption of the turbo pump should be slightly greater than that of a reciprocating pump during the working periods, so little is added to the fuel bill that this extra expense is less than the interest on the increase of investment that would be necessary for a reciprocating outfit. With coal at low price, the turbine is actually capable of very much better total over-all economy as a main unit is a high-grade triple expansion pump.

It is well known that the turbo pump requires practically no attention or expense for maintenance, and is the simplest piece of apparatus in the plant. There is nothing about the outfit that gets out of order easily and causes failure of the apparatus at a critical time. There is no danger of damage or sticking of cold parts from sudden admission of steam. A turbo pump started from rest pumps as long as steam is supplied to the turbine. Steam turbo pumps for similar reasons are also highly desirable as standby units in hydro-electric plants that have an auxiliary steam plant to help out during periods of low water or in the case of failure of hydro-electrically-driven pumps for any other reason.

It is claimed that the turbo boiler feed pumps are of great value, as these pumps work against comparatively high pressures, and they run at the high rotative speeds favorable to direct connection with the turbine.

They require much less steam to do a given amount of work than is required by a reciprocating pump, and with the latter a steam consumption of 100 pounds per b.h.p. is by no means uncommon. Turbo pumps in this service work well in connection with automatic feed water regulators, as the pump speed can easily be changed automatically to deliver the right amount of feed water at the required pressure. A turbo pump can also be paralleled with a reciprocating pump, and the two so governed that the reciprocating pump automatically starts when the other pump becomes overloaded.

A great field for turbo pumps is found in condenser work. For driving centrifugal pumps to deliver a large volume of water against a low head, as in supplying surface or jet condensers, geared turbines give a splendid steam economy by proper choice of speed ratio. Where gears are not interposed, the matter of speed is often a compromise, as pump speeds in this service may be low for the turbine. Turbo pumps are also used to handle the condensate, in which instance the operation of the pump can be made entirely automatic. This is accomplished by putting a float in the hot well and operating therefrom a throttle valve in the steam line of the turbine. The center of the pump should be at least 3 feet below water level in the hot well to assure priming and the discharge head should be over 25 feet.

It is claimed that such installations have proven very satisfactory in service, and the present tendency in power plant design is to use more and more steam turbine-driven pumps on condenser work. It is sometimes practical to mount both circulating and hot well pumps on one shaft. For mine drain-

age also the steam turbine-driven centrifugal pump is well adapted, as the space occupied is small and parts of the pump which come into contact with the water handled can be made of any desired acid-resisting material. With electric motor-driven mine pumps, flooding usually means not only an immediate shutdown of the pump, but if other motors or lights are on the same circuit, the opening of the circuit-breakers or fuses puts all these out of commission.

FRANK C. PERKINS.

Cable System Handles Dump Wagons

The Editor of MUNICIPAL ENGINEERING:

Sir—"Old Dobbin" in these days of efficient and fast moving motor truck is being rapidly crowded from urban grading jobs. Once in a while, however, thru some mechanical aid he is enabled to cope with this modern mechanical wonder. This article has to do with just such a case. Briefly, the work performed was the hauling of rock in 2-yard Troy wagons up a 16.5 per cent. grade, by means of an auxiliary cable—attached to the wagon—which made the load handled by the team almost negligible. Connecting this same arrangement of cable on another part of the work allowed the team to descend a 28.75 per cent. grade without setting the brakes and with comparative ease.

This ingenious method of handling the material was evolved by Al. Hennessy, the outside superintendent of the Federal Construction Company, and was used on a grading job that this firm had been awarded in San Francisco.

The work was done under public contract under a two-year installment plan, at a total cost of $39,517.55, and involved moving 58,677 cubic yards of material, of which 13,087 yards were in slope. The contract was completed June 13, 1916.

Owing to the peculiar topography of this district (see views), some such method of handling the material as was adopted was necessary in order to show profit. Fortunately, a short haul was available, the contractors having made arrangements with the owners to fill some of the low land adjacent to the streets graded. On Vermont street, some very heavy fills were made, necessitating raising a number of houses to the new grade.

Using the method herein described, the contractors were enabled to make the fill at small expense to themselves.

A small donkey engine (with engineer and helper), a few hundred feet of ½-inch wire cable with hooks attached, and several deadmen and pulleys were all the extra equipment necessary.

Nearby, another grading job was in progress, under the supervision of the city, on which 5-yard motor trucks were used. The haul, however, was much longer, and consequently the cost was much greater. It afforded a good opportunity to compare the two methods, as both jobs were in plain sight from the high ground. It was impracticable to use cars on account of the steepness of the ascent, this being one of the difficulties that were directly responsible for the working out of the economical method described.

JAMES M. OWENS, Asst. City Engineer,
City and County of San Francisco, Cal.

TWENTY-SECOND STREET, NEAR RHODE ISLAND STREET, 28.75% GRADE. SHOWS LOADED WAGON COMING DOWN GRADE.

VERMONT STREET, BETWEEN TWENTIETH AND TWENTY-SECOND STREETS, WAGON BEING ASSISTED UP 16.5% GRADE.

CAROLINA STREET, NEAR TWENTY-SECOND STREET. STEAM SHOVEL; ALSO WAGON WITH CHAIN ATTACHED TO REAR AXLE. THIS CHAIN WAS ATTACHED TO A HOOK ON THE CABLE.

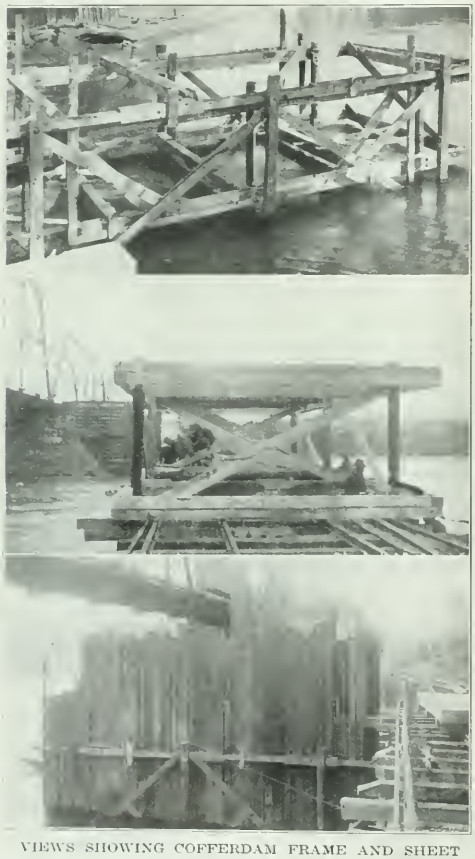
CAROLINA STREET AT TOP OF GRADE, SHOWING CHARACTER OF MATERIAL.

Outside Templates on Steel Cofferdams

The Editor of MUNICIPAL ENGINEERING:

Sir—The outside template shown in the accompanying views was built by the writer and used repeatedly in setting up and guiding the new steel sheeting for successive cofferdams required in constructing the piers for the Susquehanna river bridge, recently completed by the Robert Grace Contracting Company for the Philadelphia & Reading railroad at Milton, Pa.

The new bridge was built parallel to and directly above the old bridge, and great quantities of large riprap stone placed to protect the old piers were encountered in the 8 to



VIEWS SHOWING COFFERDAM FRAME AND SHEET STEEL PILE TENPLATE AND PILING.

15 feet of soft material that overlay the rock beneath the river bed. This made it difficult to set the steel sheeting to correct line before driving and obliged the writer to devise the template shown.

This template was an outside frame of timber 6 inches larger all around than the cofferdam bracing itself. The bracing assembled with the frame of the template was built on the work trestle, and set in place by a 30-ton locomotive crane. The wales of both the bracing and template were made of doubled 6x8-inch oak timbers, with lengths of round wood piling as upright supports and 2x10-inch yellow pine cross-braces. The template not only made it possible to set up and drive the steel sheeting true to line, but furnished a good foundation for working platforms.

After all the sheet piling at one pier had been driven, the template frame was removed by the locomotive crane and used again at the next pier site. One frame was used successively on all of the 20x40-foot cofferdams.

F. P. KENNON.

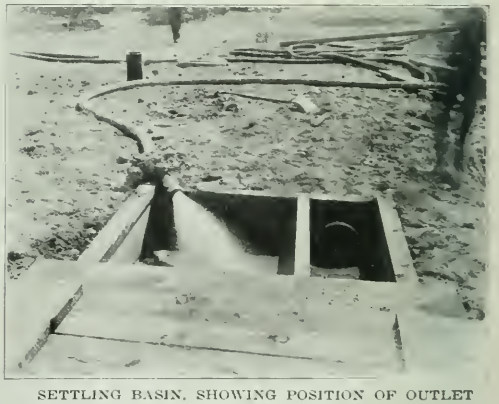
Cleaning Out Sand Catchers

The Editor of MUNICIPAL ENGINEERING:

Sir—The following is a short description of the method used in cleaning out the large sand catchers of the sewer system of the city of Seattle.

Because of the large amount of sand, gravel and other heavy detritus that gets into the sewers, it was necessary to put in large sand catchers (or grit chambers, as they are called by some engineers) in the line of the sewer.

During the rainy season, these sand catchers, which hold from 20 to 50 cubic yards of detritus, require cleaning about every ten days. This was a very expensive and disagreeable task, taking seven men and a team on an average of three days to complete the same. Mr. George Otterson, a mining engineer of Seattle, suggested that the problem could be solved by the use of a hydraulic ejector. This ejector works on the same principle as any ordinary hydraulic lift, having a water supply pipe connected to a nozzle which throws a stream of water at high velocity thru a contracted throat, thus creating a vacuum and causing a suction. The height that sand and gravel can be elevated by this ejector is governed entirely by the pressure of the water supply. It is very simple in its



SETTLING BASIN, SHOWING POSITION OF OUTLET PIPE BACK TO SEWER.

construction, as can be seen from cut. There are no movable parts to get out of order. All wearing parts are made of hardened steel, thus insuring a life of several years before they have to be replaced. When this is necessary, it requires but a few minutes' time to slip the old parts out and put the new ones in place.

Collects in Settling Basins.

With Mr. Otterson's ejector it requires but three men for one day, at a labor cost of $9 and water cost of about $3 to clean out both sides of a sand catcher holding about 22 cubic yards. The sand and gravel and all foreign material are thoroly washed by the large quantity of clear water used in lifting them to the surface. They are collected in large settling basins built on the surface, from which they are easily shoveled into wagons.

Because of the thoro washing, all offensive matter is re-

moved, and the clean sand can be dumped in any convenient place. The use of the settling basin is temporary. It is expected that a suitable wagon will be built and the material deposited direct from the ejector into the wagon. The surplus water carrying organic matter and light material is conducted back to the sewer by means of a suitable drain pipe and hose.

A. W. Howard, Seattle, Wash.

A Steel Surfaced Pavement

The Editor of Municipal Engineering:

Sir—We have a macadam roadway on West avenue, reinforced or armored with steel surfacing, covering an area 18x80.34 feet, or 160.68 square yards. The pavement is on one side of the car track, which is in the middle of the avenue. It is on a 4 per cent. grade.

Since this type of pavement is entirely new (at least in my experience), there are no precedents to follow in its construction, and it was necessary to employ methods suitable for actual conditions. The completed pavement comprises a base 4 inches thick, of crushed stone, compacted with a 10-ton steam roller; 3-inch thickness of concrete, with aggregates not exceeding ¾-inch size, mixed 1:2:4, and the steel surfacing set flush with net grade. The surfacing is made from steel plates, 2½x18 feet and ⅛ inch thick. The crushed stone base cost 30 cents per square yard, and the perforated plates cost $50 per ton. The actual cost of the work is as follows:

Base 4 inches thick	$ 48.00
Materials for concrete bed 3 inches thick	61.90
Steel surfacing delivered	180.77
Labor, including overhead expense	40.00
Total	$330.67

Unit cost, $2.06 per square yard.

SECTION OF STAMPED STEEL SURFACING.
VIEW OF NEW LAID STEEL PROTECTED PAVEMENT.

The two photographs show construction and finished work respectively. About two weeks after completion we ran a 10-ton steam roller over the surface to test for adhesion between steel and concrete. No movement was perceptible and, at the present time, the pavement is apparently in perfect condition.

Samuel H. Lea, City Engineer,
City of Charlotte, N. C.

Details of Gypsum Roof Deck

The Editor of Municipal Engineering:

Sir—The following information describes a new development of fireproof roof construction, as found in Walker Manufacturing Company's roof at Racine, Wis.

Style of building—steel frame, 190x200 feet. Roof slabs made of Structolite, a new form of extremely hard, dense structural gypsum, molded on the job. T-section 15 inches wide, 8 inches deep and 1¼ inches thick for the slab and 2½ inches for the rib. Ends closed by diaphragms 2 inches thick. Reinforcing consists of two ⅜-inch rods on bottom of rib, one of these being bent up at the ends as a shear rod and looped to increase the value of bond stress. In slab is embedded a steel wire mat of No. 14 gage, 4-inch mesh.

Erected under the supervision of the United States Gypsum Company; Architect P. L. Battey, chief engineer; B. J. Arnold Company, consulting engineers, Chicago, who were also contractors.

Slabs molded at rate of 300 square feet per hour. Slabs taken from molds fifteen minutes after being poured were walked upon three hours after being poured; designed to carry a uniformly distributed load of 50 pounds per square foot, with a safety factor of four.

Slabs carried by light steel trusses for saw-tooth portions and by steel purlins for flat portions, supporting steel spaced 10 inches from center to center. Flat roof portion has a pitch of 1½ inches in 12 inches.

Weight of T-beam slabs 16 to 17 pounds per square foot. Slabs may also be made of I-section when flat ceiling effect is desired, instead of ribbed or beam ceiling. A roof of this character is now being erected. Beams are 22 pounds per square foot.

Five sample beams 24 hours old were tested with loads of 2,200 to 2,400 pounds, or 200 to 218 pounds per square foot, deflected 0.034 and 0.070 inch; 3,500 pounds caused light horizontal shear cracks only.

Advantages of this new roof: Light weight, rapid erection in all kinds of weather, non-conducting and non-condensing, deflection of light from the white under side, and economy, the Structolite slabs being inexpensive and the steel framing used to hold the slabs in place costing less than 5½ cents per square foot.

Geo. L. Lincoln.

Will Help Locate Plants.

The Industrial Sites Association of America, with offices at 115 Broadway, New York, has recently been reorganized and incorporated. The entrance of this association into a new field of action solves a problem of long standing for manufacturers who are in quest of new locations.

The I. S. A. A. has undertaken to meet this need by compiling and classifying data concerning the properties, sites, buildings, railroad and water facilities, labor conditions, population, etc., of all towns and cities where manufacturing plants could be advantageously established—a clearing house which would supply manufacturers with complete and verified information free of charge.

By simply stating their requirements manufacturers will be rendered every assistance in the location and selection of properties. They will be given free access to all data in the possession of the association. The entire service is offered without charge of any kind.

MISCELLANEOUS

Conversion of Settling Tanks Into Imhoff Tanks Thru Use of Light Steel Forms

Without causing a complete shutdown at the Columbus sewage treatment plant, the original settling tanks were converted into Imhoff tanks by the use of light steel wall forms in standard units, supplemented by specials for intersections of surfaces in different planes. While half of the tanks were being modified, the other half were continued in operation, taking the entire flow of the plant. The outer walls of the original tanks were left in place and were used as the outer walls of the Imhoff tanks.

The contractor for this work, D. W. McGrath, of Columbus, Ohio, used Blaw light wall forms for practically all of the new work, excepting the end channels for the admission and outflow of the sewage. The latter were of such variable form as not to permit a sufficient amount of re-use of the forms to justify the use of steel.

The first operation consisted of excavating below the bottom of the old tanks, and constructing pits with concrete walls and sumps in their bottoms for the collection of the sludge. The forms were set up for one of these pits complete, a height

VIEW SHOWING FORMS IN PLACE.

of 8 feet above the top of the sump. These forms were filled and removed before the wall was carried up higher, being used again on another sump as soon as they were taken away from the first one constructed.

The illustration shows the Blaw steel forms filled with concrete for the construction of one of these sumps. The system of liners holding the forms rigidly in position is well shown, and it will be noted that on the overhanging wall the liners are bent so as to produce a wall of exactly the right profile.

The forms used on this work were, with the exception of the specials provided for the intersections, strictly standard light wall forms, adjustable for use on all plain wall work, where the height poured at any one time does not exceed 10 feet. These forms were attached to the liners before they were erected, and were shifted either in units 2 feet wide and 10 feet, 12 feet or 14 feet long, as desired, with the horizontal liners attached or in larger units with the vertical liners attached, in which case it was necessary to employ a derrick to handle the form on account of the weight. The form weighed about the same per square foot of surface as a well-made wooden form, but occupied less space and had much greater stiffness.

On this particular job the forms used in the sumps were shifted by the derrick in units 12 feet wide by 8 feet high or 96 square feet to a unit, similar units being used in the upper sections. In shifting these large units they were picked up by the derrick and swung around into a new place wherever desired, necessitating little handling.

Getting at the Haulage Cost

In an article recently appearing in the *Federal Traffic News* the basis of figuring cost per mile and dividing this cost into its component parts for purposes of comparison, has been quite clearly brought out. By the use of two diagrams the division under various conditions is very plainly shown. For a basis of cost determination the 1½-ton Federal truck is used.

On a basis previously worked out the total operating cost of the truck is divided into ten parts, five of which are fixed charges—that is, charges which remain the same for every day—and five variable charges, those which depend on working conditions usually grouped under the one head of mileage.

The various items under these two heads are:

Fixed	*Variable*
Driver	Fuel—gasoline
Interest on investment	Lubricants
Insurance	Tires
Garage rent	Repairs and maintenance
Taxes and license	Depreciation

Of all these items but one would be questioned. Many still contend that depreciation should be figured as a daily fixed charge. It may be the easier way, but this way does not always prove the best or right way. The practice of many is to charge off depreciation as soon as possible. Fifty per cent. the first year and 25 per cent. the next two years is a common practice. Any such plan would not seem so bad if the transportation costs were averaged over the entire life of the truck, but where one year is to be compared with another, the first year is at a disadvantage to all others. For the sake of a fair average it is the plan of many, including ourselves, to figure depreciation on a mileage basis.

The mind of business, thru its big men, is gradually coming

to the point where it asks, not what an article costs, but what it will do for its cost in solving our problems. We expect a certain unit of value for a unit of investment. In our transportation problems this has developed the cost per ton and the cost per ton mile, or their variations which best fit the different lines of business.

Facts That Must Be Known

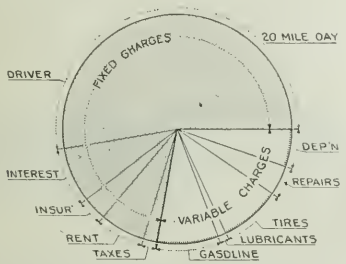
Before such costs can be satisfactorily computed a few very important items must be known, the following being the most common:

Miles of travel per day.
Tons carried per load.
Miles per round trip.
Trips made.
Deliveries made.
Hours per day.

With this data and the two charges, the daily fixed and the unit mile, we can proceed to determine our costs. The illustration reveals two important points, which we will do well to keep in mind:

First—The greater the daily mileage, the greater will be the proportion of variable charges in the whole cost.

Second—The greater the daily mileage, the less burdensome are the fixed charges in the total cost.



THE RATIO OF COST IN A 50-MILE DAY.

In the 20-mile day the fixed charges are nearly three-fourths of the entire cost. In the 50-mile day the fixed charges are only about one-half of the total cost. If we carry the same idea a little farther, we find that in a 10-mile day the fixed charge is 84 per cent. of all cost, while in a 75-mile day it is but 42 per cent.

The reason for this can be found in the fact that variable charges increase in a direct proportion to the daily mileage, while fixed charges per mile decrease in proportion to the increase of daily mileage. This will readily be seen by a few figures:

VARIABLE CHARGES

Miles per day.....	10	15	20	25	30	35
Cost per day.....$	.72	$1.08	$1.44	$1.80	$2.16	$2.52

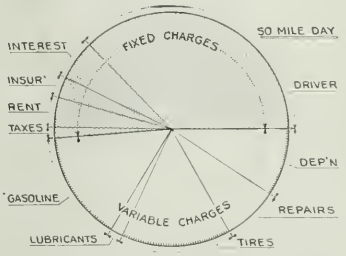
FIXED CHARGES

Miles per day.....	10	15	20	25	30	35
Cost per mile.....$	.35	$ .23	$ .17	$ .14	$ .12	$ .11

Other Factors

If the cost per ton-mile is figured according to the half-load basis by multiplying the average load in tons by one-half the daily mileage, this cost, on which basis we compare trucks, will vary greatly. This is because the factors composing this cost are variable factors. Loads, miles and daily cost, the variable factors in this cost problem, explain in themselves why costs vary.

One concrete example will make the statements plain. A 2-ton Federal, owned and operated in Reno, Nev., during three days of July, carried an average load of 3,025 pounds and made an average of 59.66 miles per day. The cost for each day's work was $8.96. The cost per ton-mile for the load carried in this case is $0.198.



THE RATIO OF COST IN A 20-MILE DAY.

We can find this by reducing the load to tons, multiplying that by one-half the daily mileage and dividing the result into $8.96.

3,025 lbs. = 1.512 tons.
1.512 × (59.66 ÷ 2) = 45.1 ton-miles.
$8.96 ÷ 45.1 = $0.198.

If a capacity load of 4,000 pounds had been carried, the cost per ton-mile would have been reduced to $0.15. Cost figures must be understood if they are to be of the most value.

Heavy Trucks Cause Vibration

Proposals of considerable importance and of not a little interest to metropolitan road engineers are contained in the following memorandum on the construction of motor omnibuses which has been issued by Sir Edward Henry, the commissioner of police for London:

"The commissioner of police of the metropolis, as the authority for licensing public carriages, desires to make the following representation with regard to the future construction of motor vehicles intended for licensing as motor omnibuses within the metropolis area.

"By the heavy motor car order, 1904, it is enacted that the maximum unladen weight of a heavy motor car may not exceed five tons and, if it is to be operated up to 12 m.p.h., the registered axle weight of any axle may not exceed six tons. In the past it has been found that the passage thru the streets of motor omnibuses approaching the maximum of unladen weight and of permissible speed caused much annoyance and damage thru noise, vibration, etc., tho fitted with rubber tires, as provided by the order.

The Unladen Limit.

"Acting upon expert advice, the commissioner, in 1909, after a conference with manufacturers and users, laid down a rule that no new vehicle would be licensed for public service which exceeded 3½ tons unladen weight, or, alternatively, exceeded a gross weight, fully laden, of 6 tons. Even with these limitations of weight, complaints of damage and annoyance continue, and the time appears opportune for reviewing licensing requirements, as the demand for chassis and parts consequent upon the war having exhausted old stocks, new construction will, when circumstances permit, have to be undertaken before new vehicles can be put upon the market.

"The experience and the developments of the last six years in the mechanical properties of materials and in designs of structural details lead the commissioner to anticipate that it will be possible to construct vehicles to meet the requirements of the public service in London with a lower laden and gross weight than 3½ and 6 tons, respectively. It is well known to manufacturers that since 1909 methods of production of gearing have been developed, which will make it practicable to

obtain silent and efficient working with lessened total weight of transmission mechanism, and some reduction may be expected in the total weight of power and of transmission mechanism thruout. Attention is also called to the method of inside lighting and of outside advertisements, as it is possible that saving in weight in connection with them might be effected.

Makers' Co-operation Invited.

"The commissioner deems it necessary, therefore, to give timely notice that new vehicles presented for licensing must be of a type differentiated from existing types by being lighter in weight, and with a better form of power transmission. He invites the co-operation of manufacturers in designing and constructing vehicles which can operate in the streets without affording grounds for complaints as to the damage done to residential property by the excessive vibration they cause, owing to their weight, and as to the annoyance caused by faulty power transmission.

"The interests of the community and of the operating companies in this matter are the same, as the introduction of a perfected type of vehicle would greatly popularize the omnibus service, to the benefit of both the operating companies and the public. The commissioner feels sure that he can in these circumstances rely upon the cordial help of manufacturers. Any representations they may put forward will, of course, receive the most careful consideration.' "

Cutting Down Finishing Costs.

Comparative costs between hand floating and finishing by the belt method, which has been recently advocated and successfully used in Wayne County, Mich., and other points, show a decided reduction in costs and truer finish with the use of the belt method. This method consists of the use of two or three canvas belts, slightly longer than the width of the road, which are worked across the road with a cross wise and longitudinal motion, resulting in well compacted, dense concrete, with a true surface.

The comparative costs are set forth in a very interesting record kept on a job in Kenton County, Ky., as follows:

By Hand Float Finish, First Class Job:

Finishers, 12 hours, at $0.50	$ 6.00
Assistant finisher, 12 hours, at $0.35	4.20
Cost per day	$10.20

Average cost per square yard, 1.7 cents.

By Belt Finishers, First Class Job:

Finishers, 10 hours, at $0.35	$ 3.50
Assistant Finisher, 8 hours, at $0.25	2.00
Cost per day	$ 5.50

Average cost per square yard, 0.9 cent.

New "Pivot-Lock" Manhole Cover

Liability risk as it existed with the old-style loose manhole cover can now be entirely eliminated by the use of a pivot-lock cover recently placed on the market. The device consists of a locking and operating mechanism which is applicable to all street and sidewalk cover plates as used by street, sewer and water departments of public utility companies. It is also used as a coal hole cover.

There are only three working parts in the device, and these are inclosed in a moisture-proof, dirt-proof housing. As the parts are packed in grease, there is little chance of rusting or sticking.

To remove one of these pivot-lock covers the operator has only to insert a "T" handle wrench in a key slot cut near the edge of the cover. This operation not only unlocks the cover, but raises it clear of the rim, also rotating it back, away from the manhole. By reversing the operation the cover is seated in place again. The key wrench cannot be removed from its socket until the cover is seated and locked. As the lifting power is applied to the under side of the cover, there is no opportunity for ice or rust to resist the proper working of the mechanism.

New Covers Used in Street Cleaning

One unique application of the new cover bears promise of a wide use. This is in connection with the efficient removal of street sweepings. In carrying out the new plan, all above ground sweeping receptacles are dispensed with. In their place fly-proof, wind-proof underground receptacles are set beneath the street or sidewalk level. The pivot-lock cover gives the sweeper easy access to the receptacles, at the same time protecting the pedestrian from all danger.

These receptacles should be evenly distributed thruout the beat of the sweeper, so that when he starts his work in the morning he finds an empty can in each receptacle. He then places one upon his push cart and starts cleaning up. After

PIVOT LOCK MANHOLE COVER.

filling his can, he would go to the nearest receptacle, open it with his key wrench and dump his full can into the empty can the receptacle contained, and close the receptacle over, hanging his key wrench on his cart and go about his business without any waste of time. The time saved enables him to take care of considerable larger area than by the ordinary method, thus cutting down the sweeping force necessary.

At night a pick-up wagon or truck equipped with a swinging arm and a set of falls, comes around and backs up to the curb. The falls are equipped with bale hooks which are hooked to two bales on the inside of the cans. The cans are hauled out and placed on the truck and carted off to the dump, emptied and brought back for the sweeper to use the next morning. The cans are at all times protected from battering and should last much longer than under ordinary conditions.

Relief From Excessive Traffic

By Eugene W. Stern, Chief Engineer, Bureau of Highways, Boro of Manhattan, City of New York.

On certain streets of all busy cities the number of vehicles is so great and the resulting congestion is so serious that students of this problem have become much alarmed and are discussing the need of more effective traffic regulation. The easiest solution of this problem appears, however, to be the better diffusion or distribution of traffic, and this can in no way be more effectively brought about than by a better and more uniform standard of improvement of the roadways of both urban and rural highways.

Why is it that so many drivers of vehicles tend to use the same street when many different possible routes could be followed? Undoubtedly the chief reason is that they wish to

use the streets that are best paved. In the case of the motor vehicle a slight detour with corresponding increase of distance is of little consequence, and time will actually be saved by the avoidance of traffic congestion; but those who are riding, especially for pleasure, prefer to follow the streets that are most attractive, those on which the abutting property has been improved to a higher degree and in a little more sightly manner. When our streets shall have become uniformly well paved and when the property along them shall have been improved according to better standards—not necessarily with palatial homes, but with good taste—when tree planting is taken up more seriously and when the space not needed for roadways and footpaths is devoted to grass plots or planted with shrubbery, those with whom time is not the important element will follow these streets, now given over wholly to the delivery wagons of the milkman, the grocer and the butcher, and appreciable progress will have been made in the solution of the traffic problem. There is, however, a very serious problem which has grown out of the use of motor vehicles; namely, the increasing weight, the increasing wheel loads and the increasing size of these vehicles. The motor or the tractor can overcome grades with heavy loads which are impossible to the horse-drawn vehicle, and highway officials responsible for the maintenance of our city streets and of the country highways leading out of them are greatly concerned at the damage inflicted upon road surfaces by these loads. The only effective remedy appears to be the enactment of drastic ordinances and laws which will absolutely prohibit the use of vehicles having more than a specified load per inch width of tire, and that load should probably be less for steel tires than for rubber tires.

The width and length of such vehicles is a matter of serious concern, especially on city streets. Where roadways have been designed to accommodate a certain number of lines of traffic and the number of lines is reduced thru an increase in the width of the vehicles, the capacity of the roadway is reduced in still greater proportion; and if this increase in width is allowed to proceed, very costly street widenings will become necessary. In this case, also, it would appear to be necessary to prohibit absolutely the use of our highways of vehicles having more than a certain specified width. The state legislature of Pennsylvania in 1913 passed a law prohibiting the registration of motor vehicles exceeding 90 inches in width of load and vehicle combined, except that motor buses for carrying passengers may be used within the limits of cities of the first, second and third classes, having a total width of 100 inches. This law also prohibits loads in excess of 24,000 pounds for vehicle and load combined or in excess of 18,000 pounds gross load on any axle, or 750 pounds for each nominal inch of width of solid tire.

Fortunately, the tendency of the manufacturers of motor trucks appears to be in the direction of more moderate loads. Of 221 manufacturers producing commercial vehicles at the beginning of the present year 133 confined themselves to those of less than three tons capacity. Of the 88 manufacturers offering trucks of more than three tons capacity, 12 appear to have increased this capacity in their models for this year, only two of these increases being to six tons, while six have decreased the capacity of their trucks, one from four to three and one-half tons, three from five to three tons, one from six to four tons and one from seven and one-half to five tons. Of twelve newcomers in the field, only one offers a truck with a capacity of six tons and two of five tons, while the rest provide for smaller loads.

While the imposition of an absolute limit upon wheel loads and upon dimensions of vehicles seems necessary to preserve our highways, both in the city and country, the development of the motor vehicle appears on the whole to present no problems to highway officials, especially problems relating to street congestion, which will not solve themselves with the more general improvement of our streets and roadways and with the adoption of a higher standard of real estate development, which will make the subsidiary highways more attractive to those using motor vehicles.

Income and Wealth.

According to the monthly letter (June, 1917), of the Alexander Hamilton Institute, Great Britain has raised by taxation but 25.3 per cent. of her war cost. This means that 74.7 per cent. was raised by a bond issue.

In spite of this precedent, however, our House of Representatives formulated a bill admitted by itself to be unscientific, which planned to raise but 40 per cent. of our immediate money by bonds and 60 per cent. by direct taxation of capital and industry.

Great Britain with a total wealth of eighty-five billion dollars has financed the war for three years. With our two hundred and fifty billion of wealth, we have little to fear even tho we are facing the possibility of financing it for the next three years, tho of course, there is no chance of our having to do this. Especially is this true when we consider that our national income is thirty-five billion dollars against Great Britain's eleven billion dollars and our national debt less than two billion dollars against Great Britain's nineteen billion dollars.

The United States enjoyes the best credit among the nations of the earth. Our national debt is less than 1 per cent. of our national wealth, and new taxation of two billion dollars during the coming year would consume only about 6 per cent. of our national income. The following table shows our financial strength in comparison with that of Great Britain, whose credit ranks highest in Europe:

	United States	Great Britain
Wealth	$250,000,000,000	$85,000,000,000
National debt	1,700,000,000	19,000,000,000
Per cent. debt on wealth	0.60%	22.35%
National income	$35,000,000,000	$11,000,000,000
Taxation, 1917-18, proposed	2,500,000,000	3,000,000,000
Per cent. taxation on national income	7.14%	27.27%
Population	102,000,000	47,000,000
Per capita wealth	$2,451.00	$1,808.00
Per capita debt	16.66	404.20
Per capita income	343.00	234.00
Per capita taxation	24.51	63.80

Pumping Lake Waters

The waters of the Great Lakes are polluted by the drainage of the cities along their shores. Even tho the sewage of Chicago is turned into the Illinois river, the southwestern shore of Lake Michigan is polluted by the drainage of at least a million people. Sewage pollution in Milwaukee travels sometimes as much as 5 miles in recognizable form, and it is estimated that shore pollution may be carried as far as 20 miles.

Intakes for water supplies from the lakes are located out in the lake in depths varying from 20 feet at East Chicago to 60 feet at Milwaukee. Pollution to some extent may reach these intakes from sewers and from boats passing near them.

Emergency intakes near shore are dangerous and interfere seriously with the operation of plants designed for the purer water of the intakes farther out, but they are sometimes necessary on account of the stoppage of the regular flow by accumulations of anchor ice.

Leaks may take place in the intake pipes without revealing themselves until an outbreak of typhoid, as in Evanston in 1912, demands an investigation.

More or less purification of the water is therefore safer than dependence on distance and depth of intake.

In a paper before the Illinois branch of the American Water Works Association Samuel A. Greeley, hydraulic and sanitary engineer, Chicago, details the methods of purification in use in various cities and towns on Lake Michigan and gives some idea of the reliability of the processes under the existing conditions.

The most popular treatment is that with calcium hypochlorite with its nearest colleague, liquid chlorine. Chicago, Milwaukee, Waukegan, Whiting, Hammond, East Chicago, Michigan City are among those using this process. The apparatus required is low in cost and is quickly installed and operated at a low cost. An emergency installation is quickly made and may need but little improvement to fit it for regular use.

One difficulty in applying this method is found in the great variations in the quality of the water to be treated in some plants. Thus at Waukegan the variations according to tests made each four hours by the starch-iodine method show changes in amounts of hypochlorite required for sterilization from 22.37 to 9.65 pounds per million gallons between 7 in the morning and 3 in the afternoon with an increase again later in the day, due to winds and lake currents changing the quality of the water at the intake. The accompanying Table I shows the variations on a number of days in the late winter of 1916, and demonstrates the necessity of keeping close watch of the quality of the water if safety is to be assured. The expense of this watch is large and offsets to a considerable extent the low cost of the treatment itself.

TABLE 1.

WAUKEGAN, ILLINOIS.

POUNDS CALCIUM HYPOCHLORITE PER MILLION GALLONS.

Date 1916.	12 to 4 a. m.	4 to 7 a. m.	7 to 12 noon.	12 to 3 p. m.	3 to 8 p. m.	8 to 12 night.
February	6. 9.45	10.96	22.37	9.65	14.60	16.71
February	3. 7.89	7.55	7.07	7.50	8.07	6.30
February	7.24.23	11.66	22.20	20.11	10.08	10.71
February	8. 7.90	5.55	13.49	9.69	13.20	13.08
February	9. 7.88	7.58	13.67	17.58	9.16	5.60
February	28.15.07	13.04	16.66	15.03	15.19	12.85
March	18 ...11.77	10.00	10.11	9.10	9.84	9.27
March	20 ... 8.24	7.57	7.44	7.54	7.90	7.65
March	22 ... 8.29	8.35	8.13	8.20	9.59	8.20
March	23 ... 6.48	8.74	8.35	7.74	7.62	7.27

Sudden change to emergency intakes with more highly polluted water sometimes strains the method beyond the danger point. Tastes in the water happen frequently in the winter as a consequence.

Rapid sand filtration is in use in Escanaba, Mich.; South Milwaukee, Wis.; Evanston, Ill., etc., the closed pressure type being in use at Lake Forest, Kenilworth and Rogers Park, Ill. The United States Naval Training Station has a slow sand filtration plant.

These plants can take care of marked variations in quality of raw water successfully, and the filtered water, when conditions are particularly bad, can be lightly treated with liquid chlorine and make the results safe and at the same time produce a water which is palatable at all times.

The filtration plant also removes turbidity, microscopic organisms and other like impurities.

It costs more to build and more to operate and requires competent supervision, the latter being required by the sterilization plants also under the lake conditions.

Filtration plants have been recommended for East Chicago, Ind., and Wilmette, Winnetka, North Chicago and Waukegan, Ill., and plans or plants are in progress for Whiting, Ind., and Kenosha, Wis. These plants must be carefully designed for the work to be done, the nature of the pollution being quite different in different towns as well as varying rapidly hour by hour in any one plant. Thus in some places microscopic organisms develop largely and affect the length of runs of filters between washings. Whiting must remove the oily taste coming from a small amount of oil refinery waste, and the creosote taste from the quench water from coke ovens, also the nuisance from glucose factory waste.

Besides the Evanston typhoid epidemic in 1914 due to leakage of intake pipe, there have been outbreaks of typhoid in North Chicago, Waukegan, East Chicago and Milwaukee which have been attributed on more or less definite evidence to the inefficiency of the hypochlorite treatment, especially on a sudden resort to water from an emergency intake when the regular supply was stopped by anchor ice.

Mr. Greeley is therefore recommending filtration plants, usually rapid sand filtration, in order to come nearer to insuring water safe at all times. He cites results obtained in the lake cities having such plants and the opinions of other engineers in accord with his.

His conclusion is that eventually all public water supplies from Lake Michigan will be filtered, the plants not yet demonstrated to demand the more thoro treatment to be subjected to careful expert supervision of the chlorine process with routine analyses at frequent intervals during the day to regulate the amount of chlorine properly to the varying conditions.

A Simple Method of Testing Sands.

During the past few years the subject of impurities in sands for mortar and concrete has been receiving rapidly increasing attention from test engineers and inspectors. Tests have been conducted along this line by the Structural Materials Research Laboratory at Lewis Institute, Chicago, and results set forth in a circular entitled, "Colorimetric Tests for Organic Impurities in Sands." This experimental work was carried out in co-operation with committee C-9 on concrete and concrete aggregates, of the American Society for Testing Materials. The comparative ease with which this test may be conducted should make it a practical one for field purposes, and therefore, one of special interest to highway engineers and contractors engaged in concrete work.

This circular will be sent to engineers, contractors and others who may be interested. It was distributed at the Tenth Annual Cement Show in Chicago in connection with an exhibit made by the laboratory illustrating by tests on concrete cylinders the effect of organic impurities in sands.

The fact that the sand has passed the colorimetric test does not by itself prove that the sand is suitable for mortar or concrete since its fineness and other characteristics must also be considered, as they affect the strength. The result of the researches, however, indicates that it is a reliable test for organic impurities which are the most common sources of danger in a sand of satisfactory granulometric composition.

Meetings of Organizations

September 24-29, at Santa Rosa, Cal.—League of California Municipalities and Annual Public Welfare Exposition of municipal streets, street and road-making machinery. F. J. Erb, director of exhibits, Pacific Building, San Francisco. H. A. Mason, Secretary, 1120 Crocker Building, San Francisco.

September 27 to 29, at Chicago Norske Klub, 2346 North Kedzie Boulevard, Logan Square, Chicago, Ill.—Informal Congress and Reunion of American and Canadian Engineers and Architects of Norwegian Birth or Descent. Joachim G. Giaver, chairman of local Chicago committee on arrangements.

October 17-18, at St. Cloud, Minn.—League of Minnesota Municipalities. Richard R. Price, Secretary, University of Minnesota, Minneapolis.

MACHINERY AND SUPPLIES

Machine-Dug Trenches for Railway Tracks

The General Engineering & Construction Co., of Rockford, Ill., sub-contractors for municipal street work, have perfected a new type of grading and excavating machine, which seems to meet in a very practical way, certain conditions in street excavation, not met by any other machine.

This machine is particularly adapted to grading in connection with the street paving work, especially where it is desirable or necessary to haul the dirt in dump wagons and where space is limited, as in many points.

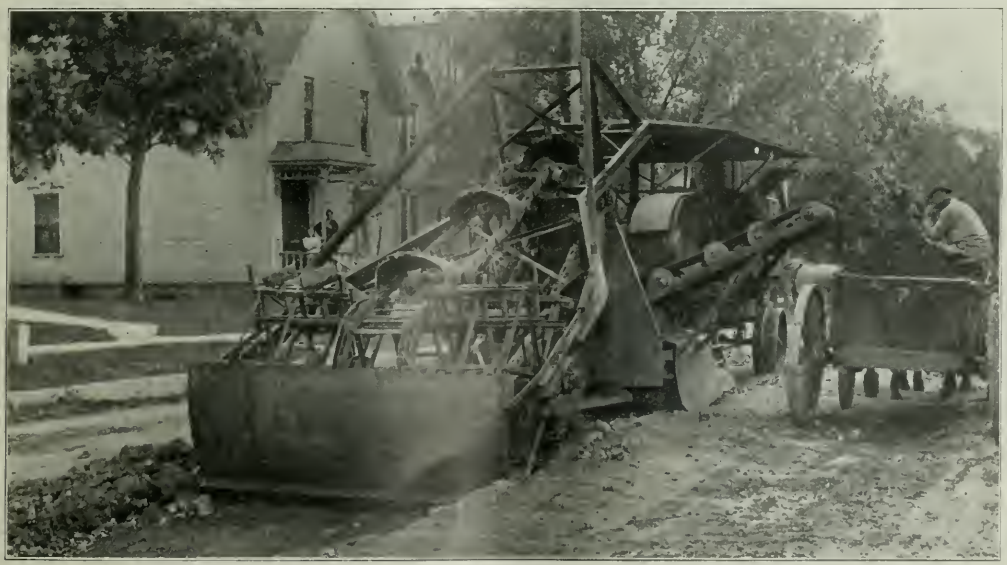
It is also adapted to excavating trench for street railway tracks. This machine cuts a strip 8½ feet wide, and will excavate 2 or 3 inches deep, or as deep as 5½ feet, the cutting wheel working on a boom being instantly adjustable by a screw raising or lowering. An indicator is provided so that the operator can run true to a grade line. The earth is deposited in dump wagons and the production is so uniform that the number of teams can each day be properly proportioned to the length of haul so that there will not be over half a minute lost team time at the machine on each trip. This is one of the points of economy in using the machine.

This machine can be run so as to cut very close to a finished fine grade, saving a considerable amount of expensive hand work. In practice, it is found best to make the outside cuts on street work first, cutting to a line to allow room for the curb and gutter and the forms. On the outside cuts, the excavator is pitched to conform to the crown of the street. If the width of the excavation should be 25½ feet, there would be two outside cuts, one cut in the center with nothing left, and the third and middle cut made flat. If the width of the excavation was less than 25½ feet, the result would be the same.

If the width of the excavation was 27½ feet wide, for instance, there would apparently be 2 feet of the side which could not be handled thru the machine. However, this extra material is taken care of by making the center cut as before, and sufficiently deep so that the 1 foot of surplus material on each side of this cut, can be leveled down and rolled into the center cut.

In practice it has been found desirable to cut slightly below the finished sub-grade, and at the last cut to finish the fine grade at once, by dumping sufficient material from the wagons to level it up to the desired grade and roll at once. Obviously, this is much less work than making a fine grade by removing surface by hand tools.

Material at alley intersections is taken care of by excavating deeper in front of the intersection for 16 to 24 feet, thereafter, to plow the intersection and slip the earth into the extra depth. This machine will work on old macadam streets if the excavation can be made 2 inches. It is seldom neces-



POWER EXCAVATOR ON GRADING JOB FOR STREET RAILWAY TRACK.

sary to root or plow the streets in advance of the machine, as the cutting drum is provided with narrow, sharp cutting teeth. This machine will also handle sand as well as fine material.

In street railway track excavation, the track trench is usually 18 to 20 inches deep and 8½ feet wide. This cut is made in one operation and the spoil put in wagons. If it is railway track work, the track may be removed closely ahead of the machine by jacks, and the trench being completed, new track can be laid directly in back of the machine, so that in case of single track work, the cars can be kept running with only a break and transfer of 150 to 200 feet. About 500 lin. ft. of track trench can be handled per day of 10 hours.

These machines have been run on work both paving and street railway in Illinois in 1914 and 1915, and have proved satisfactory and practical in every case. On one particular job, the machine compared so favorably with a steam shovel on the work, that the steam shovel was dispensed with.

New Locomotive Hopper

We are illustrating a unique device, as devised by J. C. Proctor, Seattle, Wash. This rig is adapted for the conveying of sand and gravel into batch measuring box over the mixer. The material is lifted from auto truck in boxes containing about one yard each, sand in one side and gravel in the other. The material is taken from bottom of hopper by double cup conveyors and is kept separate until deposited in the batch

LOCOMOTIVE HOPPER FOR CHARGING CONCRETE MIXER.

measuring box, at which juncture the cement is added before dumping into the mixer. This operation is repeated as fast as the mixer takes it away. The engine propels the hopper along with the mixer and lifts boxes from the trucks and dumps contents into the hopper, which should hold about three truck loads.

This device keeps material out of the mud and dust and out of the streets and eliminates the men and wheelbarrows.

Tractor Equipped with Hoist

The accompanying illustration shows a modern oil tractor equipped with a hoist as developed at Minneapolis, Minn. This oil motor is of the four-stroke cycle type with four cylinders, cast in pairs, with heads, body and valve chambers all in one solid piece. It has flyball throttling governor which controls the speed of the motor by regulating the fuel supply. A force-feed oil pump forces oil thru copper tubes directly to each cylinder, crank bearing and connecting-rod pin thru centrifugal ring oilers.

OIL TRACTOR RIGGED WITH POWERFUL HOIST.

This oil tractor with hoist is equipped with high-tension, self-starting magneto which requires no batteries. The motor is horizontal with crank shaft extending crosswise of the frame.

It may be stated that the main drive pinion and belt pulley are keyed together in a solid piece upon a sleeve which is provided with a bronze-bushed bearing and runs free upon the engine crank shaft. The power is transmitted from the crank shaft to the belt wheel and pinion thru an expanding two-shoe friction clutch, which is keyed to the crank shaft. The main drive gear is mounted rigidly with transmission gear to a solid sleeve with a bronze bushing which is free to rotate upon the main drive shaft.

The transmission system is without a single extra gear. A single spur pinion on the crank shaft engages the differential and at each end of the differential shaft are the bull pinions which drive the bull gear. The differential shaft runs in a unit bearing, consisting of a solid steel casting, extending the entire width of the frame, babbitted for several inches at each end with a space in the center for oiling. All gearing is covered with a dust-tight case. The machine is reversed by the single movement of a lever operating a simple and ingeniously arranged idler pinion, which remains entirely out of service when the tractor is moving forward.

This machine has the bridge girder frame and the front axle consists of trussed steel bars, and has only a vertical oscillating motion, with the wheels turning on knuckles, as do the wheels of an automobile truck.

It is of interest to note that the centrifugal type flyball governor is housed in an oil-tight, dust-proof, spun-brass case, is geared directly from the cam shaft, and controls the engine within a few revolutions from full load to no load by regulating the fuel supply thru a single lever connection operating directly on the throttle valve. This governor is equipped with an accurate and positive adjusting device which makes it ideal for operating a threshing machine, corn sheller, or any machine requiring steady motion.

The motor is also provided with a hand throttle so that it may be controlled by the operator while running. The cyl-

inders and crank bearings of the motor are lubricated by a multiple forced-feed oil system, the oil being pumped by a positively driven force pump thru individual pipes directly to the cylinders and bearings. This insures perfect lubrication under all conditions and speeds of motor. A splash system of oiling is also used thru the oil basin under the crank shaft, oil being carried in this basin to a level such that the connection rods dip into it at every revolution, filling the entire chamber with an oil spray. Gears and all other parts are lubricated from the main oil reservoir, the oil being carried to the bearings and gears by separate pipes provided with special lubricating valves. Thru this system of oiling, every bearing and gear face on the tractor is lubricated continuously without requiring the attention of the operator.

It may be mentioned that carburetion is secured thru a combination kerosene-gasoline carburetor which has finally made possible the use of lower grade fuels such as kerosene and distillates in this type of internal combustion motor. The carburetor is provided with a double or outer bowl thru which exhaust gases are led by a flexible tube, the consequent heating causing the lower grade fuels to volatilize more readily.

A One-Man Car-Unloader

For unloading sand, limestone and other building materials from gondola cars a new gas engine driven unloader has recently been produced. This is known as the Panama unloader.

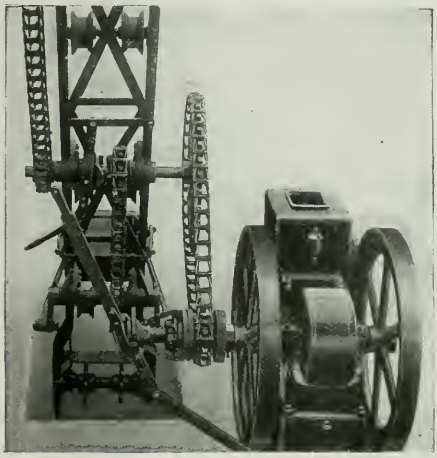
One of the principal features of this unloader is the extreme simplicity. It consists mainly of a movable-bottom steel box which fits between the ties under the track, a bucket conveyor and a 6-h. p. gas engine.

DETAIL OF MOVABLE BOTTOM—BOX OF "PANAMA" UNLOADER.

When in operation the trough is kept filled with stone or sand, which is continuously jogged forward into the carrying buckets by the backward-and-forward movement of the trough bottom. This movable bottom and the buckets are the only moving parts of the outfit, and are easily replaced when worn, and at little cost.

The Panama bin, to which the material is raised, is very strongly constructed and, as will be noted from the attached illustration, is of the center-delivery type, so that the wagons or trucks may be driven directly under it. With this method the wagons load fully and evenly. Three outlets controlled by long levers permit the operator to control the discharge easily.

Aside from erecting the framed-timber bin the only expense in connection with installing the Panama is the slight cost of



POWER PLANT OF "PANAMA" UNLOADER.

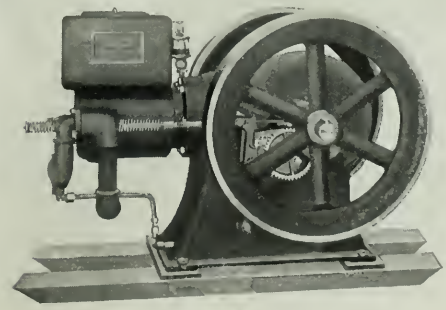
digging a trench under the track for the steel trough, and a pit for the conveyor frame. For the trough a hole a foot deep, 2 feet wide and 8½ feet long is needed. The conveyor frame requires a pit 4 by 4 feet.

It is said that the Panama will completely empty a gondola car of limestone in from 40 to 60 minutes at a cost of not to exceed a cent per cubic yard, or about one-tenth to one-fifteenth the cost of hand unloading. Thus the unloader saves its cost in a very short time.

As the Panama conveyor frame is made in two independent sections it can easily be arranged to load directly from car to the motor truck by using one section only.

Lightweight Contractors' Engine

On account of the unusually light weight of the Brownall Engine, this strong pulling machine has found considerable favor among contractors and makers of contracting machinery. It is the result of more than seven years of engine construction, during which time a special study was made of the requirements necessary to produce an extremely light weight, compact, powerful and lasting engine, adapted to contractors' work. As a result, about 100 lbs. per h.p. of weight



THE LIGHTWEIGHT BROWNALL ENGINE.

was eliminated over former designs, stronger metals of less weight being substituted for cast iron.

High speed is an important factor in lightening the engine. It was found that with the same bore and stroke, at a high speed, more power could be produced, consequently, the fly-wheel could be reduced in size and weight.

The Brownwall engine on the mixer or other contractors' outfit cuts down the weight from 200 lbs. to 600 lbs. It is of the inclosed crank case type, keeping dust and cement out of the cylinder and main bearing. Gasoline is stored in the base. The engine is built in both the water cooled and air cooled types, either one being desirable and both systems guaranteed cool. The absence of packing on the water cooled type is very important, as any chance for blowout is eliminated. The valves can be taken out and replaced in a few minutes. The entire engine is simple and easily accessible. This engine is made of 1¾-h.p., 3-h.p., 4-h.p., 6-h.p., and 10-h.p.

Trailer "Oil Distributer"

We are illustrating a type of oil trailer tank distributor as manufactured by the Good Roads Machinery Co. This outfit is designed to meet the requirements that come up in spreading oil on county and state jobs where long hauls are necessary, and where pressure distribution is desired, but with larger capacity both for carrying oil and for distributing over wider widths of road surface and in larger quantities than is possible with horse-drawn machines.

The distributing mechanism is similar to that used on the horse-drawn American Monarch distributor, but has two rotary pumps instead of one. This arrangement affords a more flexible control of the amount of material that can be distributed and permits of a much higher pressure.

The standard manifold length is 6 feet, but with the two pumps it is found quite practical to use manifold widths of 8, 12 or even 16 feet, thus saving going over a road twice where the right application of oil is made.

Experience has demonstrated the advantage of generating pressure for distributing the oil by means of the traction of the rear wheels, and this system is used on the trailer, as illustrated. Having in mind the high speed at which these outfits travel along the road, roller chains are used for the pressure generation, and roller bearings on the axles.

Specially constructed heavy springs are also used to take care of the vibration. The great value of the trailer tanks lies in the facility with which they can be handled, especially on narrow roads. With a three or four wheel tractor and a tank trailer, an outfit can be turned around without difficulty on a 12-foot road.

Conveyed by Compressed Air

The village of Highland Park, Mich., bought a Cummer stationary asphalt plant early in the spring, 1916, and during the ensuing season gave it severe usage tests in the mixing of concrete base for 113,000 square yards of street pavements.

"Of this amount," states Mr. E. G. Foster, superintendent of the Department of Public Works, "we surfaced 46,472 yards with asphalt at an average of about 1,000 square yards per day. One of our streets—Hamilton boulevard—was surfaced with 56,400 yards of creosote block. When this is completed, we are assured that it will be one of the most beautiful boulevards in the vicinity of the city of Detroit.

"The Cummer asphalt plant, which proved of such great value in the foregoing work, is equipped with three kettles of 10-ton capacity each, and has a maximum daily yardage of 1,500 square yards. The dryer is mechanically controlled with conveyors which transport the sand and stone into the heater. The mixer also is a mechanically-driven device with mechanical conveyors.

"Our asphalt is heated in kettles and, which is rather unusual, is conveyed to the mixer by compressed air. This enables us to operate the plant with the help of only a few men, about 6 in all, whose duties are to see that the kettles are kept filled with asphalt, and that the fire and the sand-dumping conveyors are provided with sand and stones.

"Haulage from the plant to points where the work was in progress was done with four Kelly-Springfield 6-ton motor trucks. These transported and dumped the mixed asphalt upon the concrete pavement, where a 12-man gang raked, tamped and otherwise prepared the fresh asphalt for the roller.

TRAILER "OIL DISTRIBUTER" OF TYPE ESPECIALLY EFFICIENT ON LONG HAUL JOBS.

"PLUTO" PORTABLE ASPHALT HEATER ON THE JOB.

Portable Asphalt Heater

By means of the portable surface asphalt heater here illustrated, the cost of making repairs on asphalt pavements has been materially reduced and the time required for the work greatly cut down. The machine is composed of a 6-foot by 6-foot iron frame carried on wheels, and provided with a battery of six kerosene burners. When in use, the heat of these burners is directly applied to the paving surface, and can be easily regulated for best results.

More than enough fuel for an 8-hour day is carried in the two kerosene tanks of the machine illustrated. Of the 53 gallons of oil required for a filling, 35 gallons are carried in the main tank and 18 gallons in the auxiliary tank. A cut-out arrangement allows for filling the large tank while operating the smaller one, so that the supply can be replenished without stopping work for an instant.

For easy transportation, this "Pluto" heater can be folded so that the heating hood is carried over the wheels, making the device take the form of a compact trailer.

In operation, the capacity of a 6-foot by 6-foot "Pluto" heater is 36 sq. ft. of asphalt in from 3 to 5 minutes, depending on the thickness of the material and other variable factors. On one Detroit job, where the machine was recently used, the foreman in charge reported that 500 sq. yd. to a depth of 1 inch had been removed in 8 hours. This with a consumption of about 6 gallons of kerosene per hour.

Motor Truck Manhole Pump

In the spring of the year and after heavy rains, considerable trouble is experienced by the Underground Department of the Rochester Railway and Light Co., because the manholes, which have no drains, are flooded with water above the cables.

The cable ducts connecting the manholes allow the water to flow from manhole to manhole until a number of manholes have become filled, making it necessary to pump the water out before any work can be done on the cables. In the past, a hand pump was used. This was very tedious work, sometimes requiring one or two hours' continuous pumping. It was decided to design an electric-driven pump and use material in the company's stock, if possible.

As shown in the accompanying diagram, a ¼-horsepower 1400 r.p.m. vertical motor and a small centrifugal pump were connected by a 3-inch spiral riveted pipe 7 feet long. The pipe acts as a support for the motor, is long enough so that the pump can be lowered into the water without submerging the motor and at the same time conducts the water from the pump to the street level. The shaft of the motor and the impeller of the pump are connected by a ⅝-inch brass rod running thru the 3-inch pipe.

The complete apparatus weighs about 170 pounds and is supported by a small crane attached to one of the company's trucks. The crane is a small pipe with a long radius bend and hook at one end, so that the pump can be swung over the edge of the truck and lowered into the manhole by means of a block and tackle.

The pump requires only a small amount of power, and the motor is operated by the battery which operates the truck.

LABOR SAVING PORTABLE MANHOLE PUMP.

The utility of the pump is shown by the fact that it will empty a manhole in fifteen minutes, whereas, it would take two men almost an hour to do the same work with a hand pump.

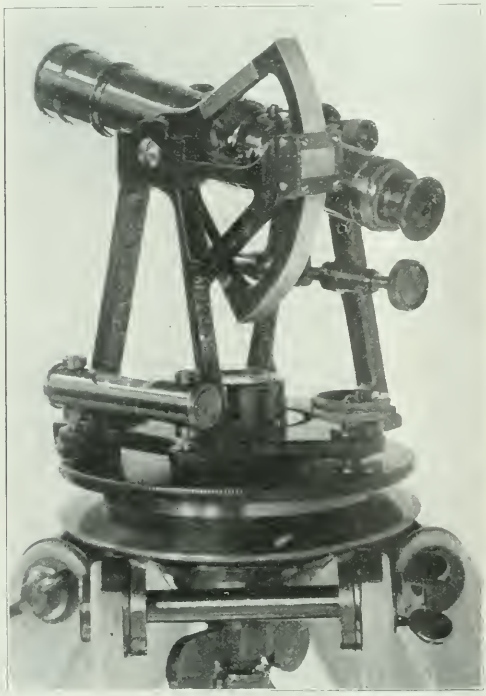
The pump is in operation every day, especially during the rainy season.

The National Safety Council has begun the issue of pamphlets on accident hazards and the best practices for the elimination. The first three are respectively on ladders, stairs and stairways, and boiler rooms. They can be obtained from W. H. Cameron, Secy., 208 S. LaSalle St., Chicago.

Instrument for Measuring Earthwork

By Frank C. Perkins, New York City, N. Y.

The accompanying illustration shows the construction of a novel Stadia cross section instrument which was designed at Troy, N. Y., for the Engineering Board of the Interstate Commission and now in use in the field by their Valuation Engineers. The instrument is unique in that it is the first one designed solely for the purpose of cross sectioning rapidly and accurately.



NOVEL STADIA PRESS SECTION INSTRUMENT USED BY NEW YORK VALUATION ENGINEERS.

This Stadia instrument for measuring earthwork with Beaman Arc is equipped with a telescope which has the usual movements and is fitted with stadia wires. The plate on which the telescope is mounted is fitted to a "Johnson" head, which is leveled by sliding on a concave surface and clamped by the upper wing underneath. The whole moves in azimuth and is clamped by the lower nut underneath. The arc graduations are so spaced and figured as to give simple multiples of the rod interval, thus determining rapidly and without intricate calculations, the precise difference in elevation and reduced horizontal distance.

In order to use this instrument, it is necessary to set the tripod in the middle of the road bed, unless the view of the road is obstructed by the bank, and in this case, the tripod is set up near enough to the edge of the bank to see the rod and set up again for the other side, noting the distance between settings.

It is then required to level the plate by the circular level, clamp the same and orient to a sight on rod held plumb and in a line at right angles to axis of the prism to be measured. It is necessary then to level more carefully by the tubular level, using the single leveling screw, and this establishes the zero which governs all readings. The stadia intercept on the rod is then read when the index of the arc coincides with any division whatever, provided the wires are on the rod. It is then possible to note on the arc V, the arc reading, intercept, and middle wire reading, and from the opposite index, to note from arc H, the nearest per cent reading. This embraces all the field work at one station, when the instrument is carried to next station, usually 100 feet.

The clerical work necessary is to compute the number of cubic yards in the prism, or the square feet in the section multiplied by 100/27. To make the computations, for vertical, the arc reading minus 50 is multiplied by the intercept on the rod. There it is required to add the reading of middle wire on the rod and subtract the height of instrument.

For horizontal, the process is to multiply the observed distance (intercept x 100) by the percentage and then the observed distance minus the product is the true distance. The area of section will be one-half the sum of the vertical by the distance between them, subtracting the two triangles. This result in square feet is multiplied by 100/27 and we have the volume of the prism 100 feet long in cubic yards.

Steam Shovel Lifts Itself

The accompanying illustration shows the Osgood "18" ¾-yard traction revolving steam shovel and its method of lifting itself so that planking may be used if necessary.

Probably the most difficult situation that confronts the contractor operating steam shovels in wet or soft ground is to keep the shovel from becoming mired. It is a hard, endless job when it becomes necessary to jack the shovel up so that planking may be used. The Osgood ¾-yard traction revolving steam shovel can be raised several inches off the ground by its own power so that planking may be used. This is done by dropping the dipper to the ground and starting the crowding or boom engines, which forces the dipper handle in a downward direction, raising wheel from ground.

OSGOOD SHOVEL LIFTED FOR LAYING SOME PLANKING.

Automatic Features Increase Mixer Yardage

With the steadily increasing cost of labor, the time element on the concrete job is becoming more and more important. Not only does the contractor have to speed up his work, but he has also to do each job with fewer men than ever. This pressure of time and men has brought the good points of the concrete paver with many automatic features to the front more strongly than ever, as the opinions of a number of leading contractors testify.

Operating information recently furnished by Culbertson & Culbertson, Richmond, Ind., accurately reflects the economical advantage of automatic action features in actual practice.

"We have been using two Koehrings on our work," states Mr. R. G. Culbertson. "One a No. 14 bought over four years ago and the other a No. 16, 1916 model.

"With the four-year-old machine we have been putting down an average of 600 sq. yd. per 10-hour day, working 13 men. This paver was equipped with an old-style loading skip, accommodating one wheelbarrow at a time. There was no difficulty of any kind encountered in the use of this machine.

"With the last year's No. 16 model, we were able to put in an average of 900 yards of 6-inch foundation per 10-hour day. It is admitted that this cannot be considered a fair working capacity for a paver, but on our particular jobs the handling of the work was handicapped by so many unusual conditions that it was not possible to secure uniformly greater average results in the way of yardage. The paver handled a 2-sack batch proportioned 1—2½—5; the sand and gravel being dumped into the loading skip from two lines of wheelbarrows. The operation of this machine ordinarily was all that could be desired, and we were especially pleased with its loading, the uniform mixing of the materials, the excellent tractive pull, which made planking necessary only at rare intervals on the very softest ground, and the steaming quality of the boiler. The discharge and the handling of boom and bucket were all that could be expected.

"The consistency of the mix was good in both machines, and each mixer was able to take care of all the material which could be delivered to it, at the same time keeping the charge in the drum the length of time required by the specifications. So far as our observation goes, the working of the machinery is as smooth as that of a stationary engine, and there was no perceptible depreciation at the end of the season's work."

On Illinois road work the Koehring automatic concrete paver has also shown up to excellent advantage. Prendergast-Clark Construction Co., St. Louis, Mo., used a No. 16 on a considerable amount of paving in Vermilion county and according to Edw. Prendergast, of that company, held the speed record for Vermilion county work last year.

"The mix on our work," states Mr. Prendergast, "was 1 cement, 2 sand and 3½ crushed rock or gravel. With the batch meter attachment, we could mix the concrete to any consistency desired, distributing quickly and easily within the radius of the boom. We consider the boom-and-bucket method of distribution far superior to chutes, as concrete mixed fairly dry cannot be as economically distributed with a chute.

"All of the past year, our daily average was 604 sq. yd. for a 10-hour day, which was the highest average of any mixer in the county. There were nine contractors in the country all working under approximately the same conditions.

"While we do not consider ours a large yardage (only about one-half of what the machine can do), it was the best in competition with eight other machines.

"All of the material for the Vermilion county work was brought up on an industrial railway truck and distributed in long piles ahead of the mixer. Sometimes three or four miles of material were on the ground. This provided plenty of material near the mixer for the wheelbarrows to carry and dump into the loading skip.

"The automatic features of our machine work nicely and are a decided advantage. There is no pounding on the back of the skip, as it dumps clean every time and never clogs. This type of machine has in our work operated very nicely and our repair bills have been very small."

A Powerful Pole Jack

To make easy the work of pulling and straightening poles a special pole jack has been devised, and is now being sold under the name of the No. 318 Simplex pole jack. This device, which has a capacity of 15 tons with a lift of 2 feet, pivots on its base and pulls the largest pole from solid ground in but a fraction of the time required by former methods.

No matter what the weather conditions may be, it is claimed that no digging around the pole is necessary. As shown in the accompanying photograph, the I-beam base of the jack is placed beside the pole, the jack is set upon it and the steel chain slung around the pole and pulled tight thru the pear-shaped link. Then the lever is operated. The jack literally jumps the pole away from the earth.

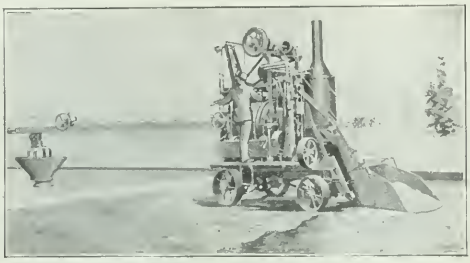
SIMPLEX POLE JACK LIFTING 40-FOOT POLE.

On account of the enormous leverage and great strength, only a few minutes are required for the entire operation. In fact, the No. 318 is said to hold the record for pulling 40-foot poles.

In straightening poles with the No. 318 Simplex, only one man is required. The I-beam base is dropped on the ground a short distance from the pole—the jack is placed thereon and leaned against the pole at an angle of about 45 degrees. With the bar in one of the two sockets, the pole is forced back a notch at a time to the exact position desired. When straight, the bar is removed and used to tamp, while the jack holds the pole in place. No pike poles are necessary.

"Standard" Street Paving Mixer

A medium sized paving mixer having a number of unique features has been placed on the market by the Standard Scale & Supply Co., Pittsburg, Pa., recently. This mixer has a capacity of 11 cu. ft. of unmixed or 9 cu. ft. of mixed material per batch. It is equipped with skip loader, steam engine and boiler and either a sectional distributing spout or a distributing boom and bucket. The bucket has a bottom discharge,



NEW STEAM PAVING MIXER.

which, while delivering, also spreads the concrete so as to materially lessen the hand work of leveling. The boom has an effective length of 20 feet and swings horizontally thru one complete half circle. All movements, including the opening and closing of the discharge, are controlled from the operator's platform. The machine is designed to equalize the weight on the four ground wheels.

A New Adjustable Paving Gage

All of the difficulties attendant upon the use of the ordinary strike board or template have apparently disappeared with the general introduction of an especially accurate steel street gage. This adjustable but rigid gage can be regulated for any street width and any crown. It serves as a gage for preparing the sub-grade, and for obtaining the required thickness of concrete, also finding use as a template and as a bridge from which the finishers can work.

An especially ingenious feature of this gage, which has just now been perfected, adds interest to the appliance at this time. This is the one-man propelling attachment. By means of this device, one man riding in the center of the gage can easily propel the whole device backward or forward at will, moving it much more smoothly than would be possible with any rope pull system. Two speeds are provided, a low for the heavy pulling made necessary when striking off a concrete base, and a high for running backward, and for striking off light materials.

Two templates are provided with each gage. Both are steel shod, and are fastened to the mast in the center of the gage, being attached at the outer end to the steel extension plates. On each side of the templates are trestle rods that hold the gage rigid, adjustable nuts being provided with lock nuts to set and hold the templates to the desired crown. From 2 inches to 4 feet can easily be added to the length of any gage by drawing out the extension plates. When the adjustment desired exceeds 4 feet, it is only necessary to procure new templates of such dimensions as will make the machine the desired width.

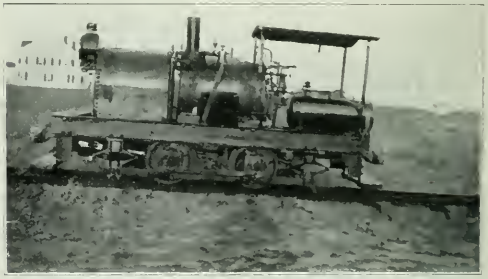
The improved device is known as the Roughen adjustable paving gage.

New Type Steam Locomotive

We are illustrating a new type of contractor's steam locomotive, the machinery or engine parts of which are all confined to one unit, so small and compact that it can be installed in the narrowest gage locomotives. The engine unit includes such features as roller bearings, drop forged parts thruout, and the highest grade material and workmanshiip and all working parts are enclosed in an oil-tight dust-proof case.

The boiler is of the horizontal type with shell and firebox head of one piece of pressed steel, and smokebox head welded in. The shell is wound with several layers of piano wire, thus giving it great strength without excessive weight. The tubes are expanded into the front head and brazed into the rear head from the inside of the boiler by a patented process.

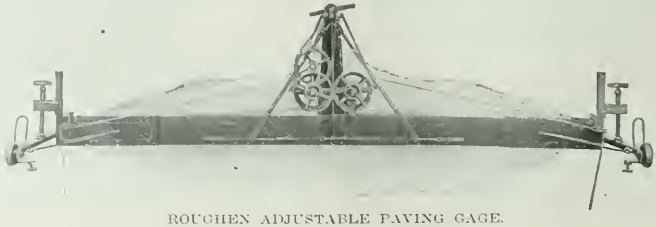
The fire is so distributed that it gives maximum heat to the lower tubes, and only a comparatively low heat to the tubes above the center of the boiler, or those tubes not under water. In other words, there are tubes where stay bolts are usually employed, and this feature gives superheated steam without the addition of superheaters. There are no stays, seams or rivets.



CONTRACTOR'S NARROW GAGE LOCOMOTIVE.

The boiler plant is extremely compact, absolutely safe, easily cleaned and so designed that all the tubes may be removed and replaced in one unit when necessary in from one to two hours' time. A steam pressure of from 300 to 350 pounds is carried and at this pressure, the factor of safety is at least 10. The boiler may be fired from cold in 10 to 30 minutes, or fired instantly after a one hour's stand.

These features furnish the contractor with a locomotive that will run on any fuel, from gasoline and kerosene to crude oil, or coal or wood, a locomotive that will give no smoke or sparks when burning kerosene or fuel oil. This type of Bell locomotive may be started quickly and has the speed of the direct connected locomotive combined with the power of the geared locomotive.



ROUGHEN ADJUSTABLE PAVING GAGE.

Two-Mile Haul Saved by Drag-Line

Mills & Baker, contractors of Casper, Wyo., have secured a big gravel-hauling contract, and the accompanying illustrations show how an ingeniously arranged drag-line outfit saved them 2 miles extra haulage on every trip.

The installation is located slightly less than 2 miles west of the town of Casper. It was found that material on the near bank of the river contains too much silt and loam for use of making concrete, but that material on the further bank holds ingredients in the rightful proportions.

The Mills & Baker plant is installed to both load and haul the gravel from the far side of the river, saving a 2-mile haul from the nearest ford, which is a full mile upstream from the town where the mixing has to be done.

A 1-yard back-dump Pioneer excavating bucket is employed and the pole is 12 by 12 Douglas fir, spliced in the middle at the spider, which is itself 7 feet across between tension rods. These tension rods are 1⅛ inches in diameter and are equipped with turn buckles for taking up the stretch in the rods. The slip is reduced to almost nothing by shoes at both ends of the rod, fastened firmly to the pole.

All blocks at the top of the pole are hitched with three loops of ⅞-inch steel cable and have worked perfectly ever since first being installed. The bucket operates on a 1⅛-inch Hercules wire rope, 600 feet in length. The drag cable is ⅝ inch in diameter and of the same make as the rope. The blocks are of unusually large diameter and self-lubricating. Five guy wires, each 1 inch in diameter, are provided to resist the strain on the large track cable. This is necessary for the reason that the bucket and load weighs about 5,500 pounds.

The tension and drag cables are operated by a boiler, which burns fuel oil, together with a 40-h.p. double-drum hoisting engine. A hoisting engineer and a fireman are the only men needed for the management of this equipment.

The round-trip across-river haul averages only about 2.5 minutes.

The unusually low construction of the bin was so made with an eye to later adding a screening equipment. Gravel from the bin is dumped by gravity directly into the wagons by a chute. Mills & Baker procured their equipment from H. W. Moore & Company of Denver, Colo., who also attended to the installing of same.

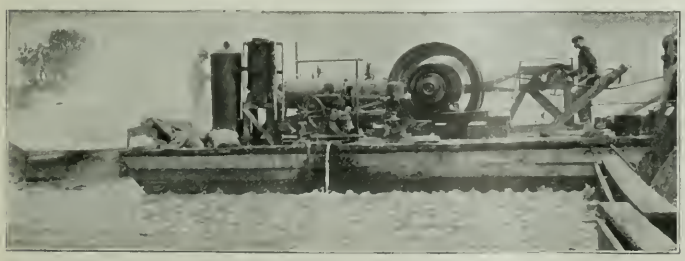
Oil Engine Sand Pumper

To secure clean sand in large quantities the Platte Gravel Co., of Nebraska, has put in service a 50-h.p. oil engine and rotary sand pump which are belt connected and carried on a large scow. Sand is drawn from the bed of the Platte thru a suction pipe, passing thru the pump and then thru a pipe line to the bank of the river, from whence it is carried to the top of a head-frame where the sand, gravel and water are thrown against a screen.

The size of the gravel allowed to pass thru with the sand is determined by the size of the screen mesh. Having passed thru the screen, the sand is promptly loaded into railroad cars, the water returning to the river.

The engine, which is a product of the Chicago Pneumatic Tool Co., has been in operation for more than a year and in continuous operation during the summer season last year without even a roof placed over it, or any protection whatever from the weather.

The outfit is working on an average of fourteen hours per day and is looked after by workmen having no engineering experience.



OIL ENGINE SAND PUMPER.

Field Telephone for Road Work

Contractors on the lookout for short-cuts will find of interest the application of the telephone to road work as recently made by one of the contractors on a section of the Vermilion county (Illinois) bond roads.

Working in conjunction with the Granite City Lime and Cement Co., contractors for the section, the telephone company spliced drop lines from one of the party lines so that a connection was available about every 1,000 feet.

The telephone instrument supplied was provided with an extra loud gong so that it could easily be heard at long distance and above the grind of the mixer. All of the apparatus was enclosed in a weather-proof box, and the box was suspended by a spike from one of the posts.

As the work progressed the box was carried forward to the most convenient lead, and was hung in place on a post. Clips provided for making connection made splicing unnecessary and always insured a good connection.

The telephone used in this way much more than paid for itself, as it enabled the office to keep constantly in touch with the job, and cut in two the time necessary for securing repair parts. Delays incident to shortage of material were completely avoided.

Municipal Research

The New York Bureau of Municipal Research worked on twenty-one assignments during 1916, including all kinds of investigations from general surveys of the city and county governments of San Francisco; Columbus, Ohio; Plainfield, N. J.; North Adams, Mass.; to audits of accounts of departments in such cities as Jamestown, N. Y. The work was done at the instance of city, county or institution governments at the expense of the administrations or of public spirited citizens' organizations.

Paulina, Iowa, Electric Light Plant

Paulina, Iowa, has an electric light plant operated by oil engine of which the following is a description:

The plant consists of one 50-h.p. 2-cylinder horizontal Mietz & Weiss oil engine operating at 275 r.p.m., directly coupled to a 30-kw. generator by means of a flexible coupling of the Mietz & Weiss type. The generator is a 110-220-volt 3-wire machine.

The town of Paulina has approximately 1,000 inhabitants. The plant supplies light for the town and power for one moving picture show.

The streets are lighted with 149 tungsten lamps; those in the residence portion being either on side brickets or center suspended. In the business section 5-light electroliers are used. The plant was put into operation about October 1, 1910, and has been in continuous operation ever since. The contract for installing this plant was taken by the Inter-

state Electric and Manufacturing Co., and the plant was installed complete, including pole line, power house, oil tank, engine, generator, switchboard and all necessary appliances, and turned over to the city in operating condition.

The following information regarding the cost of operating the plant is taken from an annual report of the plant:

Received for electric light	$3,793.95
(This item does not include any charge whatever for the 149 street lamps.)	
—Expenses—	
Salary for superintendent of public works	1,320.00
Repairs for light plant, including miscellaneous supplies, etc.	65.58
Fuel for light plant	339.63
Lubricating oil for light plant	43.98
Total cost of operation	$1,769.19
Gross profit for the year	$2,024.76

About $1,500 worth of street lighting was furnished during the year which would make the total profit for the year about $3,500.

This plant has proven very economical to operate and has given very satisfactory service. It has an excellent record for its continuous run without trouble.

A similar engine of 18-h.p. for pumping city water has been installed since the electric light plant has demonstrated its value.

Trade Publications

Viking power pumping units for pumping road oils and asphaltic compounds are well described and experience with them is detailed in a circular issued by the Schirmer-Frensdorf Co., Cleveland, O.

The low-priced big-money maker for the contractor, known as the "Dandle" mixer is exploited in a striking circular of the Koehring Machine Co., Milwaukee, Wis.

"Modern Building," a periodical devoted to the manufactures of the Trussed Concrete Steel Co., Youngstown, O., is a real magazine of much interest and value on its subject.

The National Lumber Manufacturers' Association, 925 Lumber Exchange, Chicago, Ill., has issued Technical Letter No. 8 on standard specifications for creosoted wood block pavement, which is accompanied by a substantial reprint of the specifications adopted in October by the American Society of Municipal Improvements.

The Gramm-Bernstein Motor Truck Co., Lima, O., have issued a new catalog of their line of one to six-ton trucks and the many uses to which they have been put. This truck is a pioneer, having been manufactured for 16 years and kept in the fore front of the procession all the time.

Extension of bituminous road building into country districts, remote from permanent plants, has created the need for easily portable asphalt mixing plants. It is to meet this need that the Iroquois Works of The Barber Asphalt Paving Company has designed several types of plants, ranging from 800 square yards to much larger capacity. These plants and their operation are described in an illustrated bulletin (No. 2A) just issued by the Iroquois Works, Buffalo, N. Y.

Fighting the flameless fire by the use of rust-inhibitive Antoxide is described in a booklet of Harrison Bros. & Co., Philadelphia, Pa.

Official Index to State Legislation, 1917, subscription $2.00 for the year. F. O. Poole, Secretary of Joint Committee on National Legislative Information Service, 42 West 44th street, New York.

The National Paving Brick Manufacturers' Association has issued an edition of the specifications for various types of vitrified brick street and road pavements in a single bound volume.

Federal Traffic News gives the monthly news regarding Federal motor trucks, made by the Federal Motor Truck Co., Detroit, Mich.

The sixth of the series of booklets issued by the Sun Co., is devoted to filling and shipping oil, mainly to wooden barrels.

Money makers for the road contractor are shown in a new circular of the Austin-Western Road Machinery Co., Chicago, Ill., and include traction grader, kerosene motor roller, tandem pavement roller, portable crushing plant, pressure road oiler and scarifier.

Bulletin 43503 of the General Electric Co. is a story of the application of Novalux units to ornamental street lighting, told mainly in pictures, which should be a valuable guide in the study of modern street lighting units.

A series of booklets issued by The Barrett Company tell "How a Tarvia Macadam Roadway Is Constructed," how "Tarvia Preserves Roads and Prevents Dust," and the characteristics and methods of use of "Tarvia B" and "Tarvia X."

Publications Received

Unification of Local Governments in Chicago, a report prepared by the Chicago Bureau of Public Efficiency, Harris S. Keeler, Director, 315 Plymouth Court, Chicago, Ill.

Colorimetric Test for Organic Impurities in Sands, by D. A. Abrams, professor in charge of laboratory, and Oscar E. Harder, chemist. Lewis Institute, Chicago, Ill.

Control of Corporate Finance, by Louie H. Oberreich, being bulletin No. 10 of the Indiana Bureau of Legislative Information, Indianapolis, Ind.

The Trend of Legislation for Public Health, by Arthur Connors, being bulletin No. 9 of the Indiana Bureau of Legislative Information, State House, Indianapolis, Ind.

Road Material Surveys in 1914, by L. Reinecke, being Memoir 85 of the Canadian Department of Mines, Ottawa, Ont.

Investigations of Gravel for Road Surfacing, by T. R. Agg, being bulletin 45 of the Engineering Experiment Station, Ames, Iowa.

The Traction Resistance on Curves of a 28-ton Electric Car, by Edward C. Schmidt and Harold H. Dunn, being bulletin 92 of the Engineering Experiment Station, Univ. of Illinois, Urbana.

The United States Government Specification for Portland Cement is published in Circular No. 33 of the United States Bureau of Standards, Washington, D. C., and is for sale by the Superintendent of Documents, Government Printing Office at 10 cents. The specification has been adopted by the American Society for Testing Materials.

The Elements of State Budget Making is the subject of issue No. 80 of the Bureau of Municipal Research of New York.

The Year Book of the American Society of Civil Engineers gives lists of its various classes of its 8,225 members, requiring 371 pages.

Folwell's Municipal Improvements, $3.50 net. John Wiley & Sons, New York.

"City Residential Land Development" is a selection of 27 of the plans for laying out 160 acres of land for residential purposes, which were presented by competitors for prizes offered by the City Club of Chicago. Cloth, royal octavo, 146 pages, $3 plus postage. University of Chicago Press, Chicago, Illinois.

The American Water Works Association has printed in booklet form its standard specifications for hydrants and valves, as adopted in 1913 and revised in 1916.

FIRE DEPARTMENT

Chicago Company Sets Speed Record

What is said by officials of the fire departments to be a world's record in an official speed test in responding to an alarm and getting into action to fight an imaginary fire was established recently by the members of engine company No. 48 at Fortieth and Dearborn streets, Chicago, Ill.

At the command of Assistant Chief E. J. Buckley, department inspector, the firemen leaped from their beds into fire togs and within twenty-one seconds had coupled their engine to the fire hydrant outside their quarters and were throwing a stream of water with 100 pounds pressure from a lead of hose 300 feet in length.

Captain James Hughes and Lieutenant Thomas Tuite are the commanding officers of the company performing the record feat.

Los Angeles Fires Cut 50%

Since the organization of the Bureau of Fire Prevention and Public Safety of Los Angeles, Cal., about six months ago, fires in that city have been reduced by at least 50 per cent. The great decrease in fire loss is attributed partly to the fact that the bureau has strictly enforced the regulation requiring basements to be kept clean, and has also seen to the installation of automatic sprinkler systems and fireproof partitions where necessary.

Fifteen engine companies are stationed in the three fire districts of the city, each furnishing an officer for inspection. As the companies work on the two-platoon system there are fifteen of these men on the job every day, each having his individual map, and each being directly responsible for the condition of buildings in the territory he covers.

When this bureau went into effect, conditions that were almost unbelieveable were found in the downtown districts, especially as to basements of grocery stores, warehouses, dry goods stores, etc., where boxes and rubbish would be piled up so far as to even block exits, the results being in case of fire the loss of life, if not by fire, thru panic. In this branch of the work the department eliminated all such existing conditions within such a short time, until now it is almost impossible to find basements of any kind that are in the least extra hazardous.

Only a short time ago, one of the most stubborn fires that has occurred in many months resulted from a gasoline explosion in a downtown basement of a cleaning establishment. Just two weeks previous to this fire, the chief inspector, while in this very basement on a trip of inspection, prophesied that here would be the next disastrous fire. This was one of the worst fires the department has had to fight in the downtown section, resulting in the injury of fourteen firemen.

Gilbert, Minn., Tests Jeffery Quad

In a pumping test recently made by the Gilbert (Minn.) fire department, a newly purchased Jeffery Quad fire truck showed an efficiency that even exceeded the expectation of the purchasers.

During the course of this test the Pagel pump threw 496 gallons of water per minute thru the nozzle at 180 pounds

REO TWO-TON MODEL J FIRE TRUCK "ON THE JOB."

pressure and 590 gallons per minute thru two lines of hose and two nozzles at 148 pounds pressure, much exceeding the guaranty of 500 gallons per minute at 120 pounds pressure. This was done without undue engine speed and no apparent effort on the part of the machine.

The machine is what is known as a triple combination pumper and chemical, with hose body, having a capacity of 1,200 feet of hose. The machine will supply pressure in the upper part of town, where the head is not sufficient from the water tank to provide a stream sufficient to quench fires. The grade-climbing and snow-bucking ability of this machine and its ability to supply pressure gives Gilbert a machine which will provide it with ample protection from serious fires.

Detachable Fire Hook

The inventor of a recently patented detachable fire-ladder hook claims that his device has features of such value as to replace in a great degree the permanently attached hook and ladder equipment. This new aid to fire fighting was patented by Howard M. Lucas, of the Canal Zone, Panama.

Mr. Lucas' hook is a very solidly built and simple arrangement, consisting of two side bars hooked at one end to grip the window seat, and at the other to support one of the ladder rungs, these bars being substantially joined by two rods. A revolving member turning around the upper rod is provided with hooks which fasten one of the rungs of the ladder firmly in place. This construction is made plain in the accompanying illustration.

Practically any size or length of ladder can be used in connection with this hook. On trials made with 30-foot ladders, the device has been found to work to perfection, permitting the scaling of a wall to a third or four-story window. Use has also been made of the hook as an adjunct to a lifeline, providing quickly a very solid anchorage.

On tests made with the detachable hook a total weight of 1,150 pounds was suspended from the device. Even under this heavy weight, the iron showed no signs of giving way, nor did the hooks give any evidence of slipping out of place.

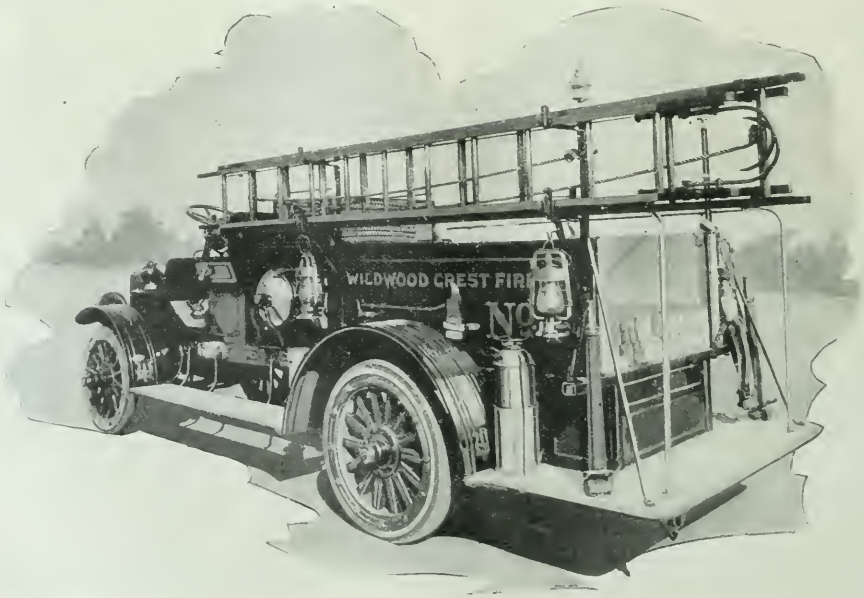
HARLEY-DAVIDSON MOTORCYCLE EQUIPPED WITH FOUR PYRENE CHEMICAL FIRE EXTINGUISHERS. ABLE TO DODGE THRU CONGESTED TRAFFIC AHEAD OF BIGGER APPARATUS AND ARRIVE IN TIME TO CHECK BLAZE WHILE IT IS STILL IN ITS INCIPIENCY.

A considerable saving is claimed on behalf of the new invention on account of the fact that a broken hook does not mean a discarded ladder.

Mechanical Lungs for Protection of Firemen

A recent invention is a smoke-mask suit for the protection of fire-fighters. It operates on the same principle as the human lungs. A small oxygen tank is carried in a pocket attached to the suit and with this are connected two tubes, one of which goes to the wearer's mouth and the other to his nose. Numerous other air-circulating tubes connected with the wearer's nose are provided thru the suit.

Exhalations from the wearer's mouth are transmitted to the tank and there come into contact with the oxygen.



GRAMM-BERNSTEIN COMBINATION HOSE AND CHEMICAL AS OPERATED BY CITY OF WILDWOOD CREST.

Vol. LIII. — No. 2

Municipal Engineering

The World's Leading Municipal Publication

August, 1917.

A GOOD TIME FOR COST-PLUS CONTRACTS

Under stress of war conditions the Army and Navy Departments of the federal government are leaning heavily upon the cost plus a percentage plan of awarding contracts. While this action is based primarily on the imperative need of rapid preparation, which leaves scant time for advertising for bids, etc., it is doubtless based in part also upon the desire to proceed at a minimum of expense by eliminating much of the hazard always present in contracting work and intensified under war-time conditions. Is there a suggestion here for the guidance of civil authorities charged with the responsibility of awarding contracts? There is.

The merits and shortcomings of the "cost-plus" plan under peace-time conditions are well understood. While attractive in many ways, notably because it reduces the hazards to which the contracting business is subject, the plan has not been widely adopted because it tends to eliminate competition and to discourage efficiency for the sake of economy. The plan ordinarily makes for higher costs, tho it may produce better results. There are always contractors willing to gamble on the weather, soil conditions, ground water, etc., who figure themselves sure to get a good break all the way thru the job. Such men are the low bidders and they get the jobs. Under ordinary conditions construction is undoubtedly carried on at lower costs under the free bidding plan than under the "cost-plus" plan.

When to all the uncertainties which plague the contractor at the best of times are added other uncertainties peculiar to war times, it should be apparent to the least discerning contractor that his bid must have an ample factor of safety in it. He is likely to bid very high to protect himself against all the contingencies at all likely to arise. He will strive to protect himself against labor shortage, violently fluctuating material supplies and costs, etc. He will almost surely figure his costs too high in war times, just as he is prone to figure them too low in ordinary times. He will become over-cautious and his bids will be proportionately above normal.

Reasoning from the premise that no community wants to stick a contractor, much less drive him into bankruptcy, isn't it only fair to conclude that in times of abnormal hazard the community should assume the risks? The cost-plus plan would seem to safeguard the interests of all parties in these times. A wide adoption of this plan will make for a maximum of construction during the war.

BUY LABOR-SAVING MACHINERY NOW

When labor-saving machinery was new in the construction field it had many prejudices with which to contend. It is no joke to say that many contractors were opposed to such machinery for political reasons. A gang of one hundred men had one hundred votes for the contractor's candidate, while the machine that chased these men off the job couldn't vote at all. What chance did the machine have?

Then there was that age-old prejudice against a machine of any kind, be it a sewing machine, a cotton gin or a tamping machine, that was brought out to supplant labor. The inventor of the sewing machine came mighty near getting lynched, down Boston way, for putting a lot of tailors out of business. So far as we know, no manufacturer of contractors' labor-saving machinery has been mobbed, but such men are likely to be bombarded at any time—with orders for the machinery.

There is a labor shortage in this country right now and it has been with us for months. The labor shortage will certainly become much more pronounced when the draft law gets to working. And that isn't all. Canada and France are both appealing for American laborers, and are getting some of them, too. They will get more later on. Our own military labors, back of the lines, will require skilled and unskilled laborers by the thousand.

Clearly this is the time for contractors and constructing engineers to buy labor-saving machinery. Our labor shortage is probably only beginning. It will doubtless continue after the war and may very easily be worse then than now. It appears likely that more aliens will leave this country than will be replaced with immigrants at the close of the war. Europeans who survive the war will stay at home to rebuild their wasted cities and public works. Their countrymen who have been sojourning with us will go back home to help in the building of a new Europe, to visit and to view the ruins.

It is a safe forecast that we will have a labor shortage in this country for some years to come. In addition to what we have enumerated, new lands are being opened up which will be farmed after the war. Our growing foreign trade will keep on growing and will call for more and more labor. We will also have our war losses.

American contractors have never had an easier decision to make than that they should buy labor-saving machinery now.

STREET AND ROAD PAVEMENTS

THEIR DESIGN, CONSTRUCTION AND MAINTENANCE

(Continued from July Issue.)

Description of progress, including points on best practice in concrete road construction, as based on knowledge gained by inspection of concrete pavements in various parts of the country.

"If the best concrete roads are to be constructed," states Mr. A. N. Johnson, consulting highway engineer, Portland Cement Association, "more attention must be paid to the nature and character of the concrete. Definite proportions having been adopted for the cement and aggregates, the quantity of water plays the most important part in the strength of the resulting concrete.

"The problem before the practical road builder is how to secure as nearly the right amount of water as possible. Owing to the variation that exists in the aggregates, it is difficult to secure the precise amount of water that will give the maximum strength with a given amount of cement and aggregates. Moreover, as the exact amount of water for maximum strength gives a rather stiff constituency, there is the practical difficulty to get the foreman in charge of the work to use such stiff mixtures. Therefore, it is necessary to use a small surplus of water in order to manipulate the concrete readily and work it in place. This excess of water, however, can be corrected to a large degree by the subsequent manipulation which the concrete receives.

"All who have examined the concrete pavements laid at Sioux City, Iowa, and Macon, Ga., have remarked upon their uniform excellence. This excellence is not to be accounted for alone by the fact that good aggregates were used, or that soil conditions were peculiarly favorable because good aggregates have been used in many places and the soil conditions in Sioux City and Macon present a variety of conditions.

"There is, however, one outstanding feature in the construction of the pavements at both of these places, which in the opinion of the writer, is the chief cause for the uniformly excellent results obtained, and that is the concrete is so manipulated that the excess water it contains is removed.

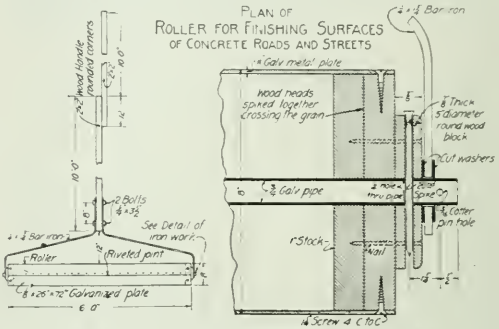
"The method used to accomplish this in Sioux City, while effective, is more expensive and not as satisfactory as the method developed in Macon, Ga., by Captain J. J. Gaillard, city engineer. Captain Gaillard's method consists of rolling the concrete with a light hollow sheet steel roller about 6-ft. long and 8-in. in diameter, in which are inserted wooden ends supporting an axle, to which a hail is attached carrying a long handle. The details of such a roller are shown in accompanying sketch.

"The manipulation of this roller is as follows: Immediately after the concrete has been struck, or placed, it is rolled by moving the roller transversely across the street or road. In case of an exceptionally wide street the handle is long enough to reach a little more than half way across the pavement. On a narrow street or ordinary country highway the handles will be long enough to enable the workmen to roll the entire width of the road, working from one side.

"The effect of the roller is that of a rolling squeegee—it consolidates the top layer of the concrete and removes practically all of the surplus water. At the same time, it takes out the slight uneven places in the surface which may occur, particularly if the pavement has not been struck by a template. The rolling should be continued until free water ceases to come to the surface, when it is ready to be finished by the canvas belt. The effect of the belt is to give uniform, gritty texture to the surface."

Measuring the Wear.

"With the use of rigid types of pavements or pavements which rest upon a rigid base, the methods that have been devised for measuring the wear of macadam roads are open to considerable error, aside from usually clumsy. Most of these devices provided for reference points at the sides. But where the pavement consists of a rigid slab or rests upon one, the

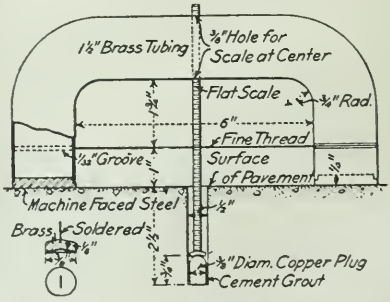


SIMPLE ROLLER FOR CONCRETE FINISHING.

observations that will be secured from a straightedge or wire stretched across the road are often quite useless, due to the movement of the slab and the possibility of its fracture because of unequal settlement. The method here proposed will overcome such difficulty and is also extremely simple and convenient.

Wimple Device for Measuring Wear of Concrete Pavements.

A drill hole ½-in. in diameter is made in the pavement. In the case of a concrete pavement, it may be 2 or 2½-in. in depth. In the bottom of the drill hole is set a copper plug about ¾-in. long, with its top made semi-spherical. The plug



DEVICE FOR ACCURATE MEASUREMENT OF WEAR OF CONCRETE SURFACE.

is imbedded in the hole with cement paste. A short steel scale divided into inches and hundreds, small enough to be placed in the drill hole, is provided. At its end is a small button with conical undersurface, which is to rest on the

spherical end of the copper plug. Across the surface of the pavement bisecting the drill hole is stretched a fine thread, and measurements are made with a scale. The hole is then filled with a wood plug, left flush with the surface, which is to be removed when subsequent readings are to be made.

A better and probably more convenient method would be to have a U-shaped handle, which will span about 6 in., having flat ends on the legs. Drawn between the supports is a tightly stretched thin thread or wire 1 in. from the surface of the pavement. This is to be held so that the thread will be over the center of the drill hole. The flat ends of the legs rest on the pavement surface and the measurements are made to the thread. The fact that the thread is raised above the pavement will make it possible to read the scale more conveniently, and is an easy method of holding the thread. The bridge or U-shaped handle holding the thread may first be placed longitudinally with respect to the pavement, then transversely, and in as many other positions as desired, the average of all readings is taken. The handle may be made of hardwood, with metal-shod legs, or of a bent hollow brass tube about 1½ in. in diameter.

This simple method will give, it is evident, data from which the exact wear at any point of pavement is desired. A line of drill holes, spaced about 15 in. apart, at various places in the pavement, would give sufficient data to determine the variation in the wear at different points. In the case of concrete pavements these data would be of special value to determine what influence variations in the materials of the concrete had upon the wear. The accompanying sketch illustrates the apparatus.

Machine Finished Surface

"The striking and finishing of the surface of a concrete road or pavement is an operation which demands the exercise of intelligent and painstaking labor," states Mr. M. DeGlopper, County Engineer, Oakland County, Mich.

"Its hard, unyielding surface cannot be altered after construction; any depression and unevenness of the surface, which is sure to follow crude or improper finishing, always remains. These not only result in discomfort to the traveling public, but a greater degree of wear results if the surface is uneven.

"Contractors must understand that good workmanship means better prices. No community will stand being 'stung' more than once, and in the future the competent, painstaking road builder will find his services in ever increasing demand.

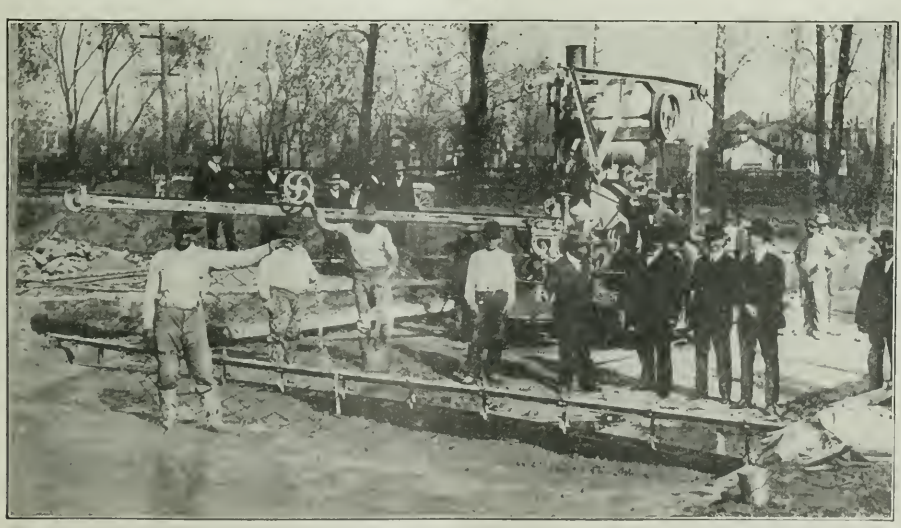
"The first essential in getting a good finished surface on a concrete road, whether hand or machine finished, is the right kind of side forms, and the placing of them to the exact grade. If they are too weak, so as to bow out between stakes, the pavement will sag, causing a depression at the crown. If they are warped vertically, a rise or fall will occur at the centers and where they join. Get the best side forms and keep the concrete off the top of them.

"If finished by hand, the next important thing is the strike. It not only must be strong, rigid and durable, but light enough to be operated by as small an amount of labor as possible. Rigid to retain the desired curvature and withstand the pressure of an accumulation of concrete. It must be shod with steel on the under side, where it is curved to the exact crown of the road.

"Here it might be stated that a circular crown to a road or pavement is the easiest thing to produce. If the attempt is made to make a parabola top (one that is flatter at the crown and the curvature increases more abruptly toward the edges), with a strike having that curvature on the under side, it must be pulled straight ahead, as any sawing of the strike over the side forms, as is usually done, will result in a deformed surface. The circular crown permits the strike to be drawn back and forth without changing the crown.

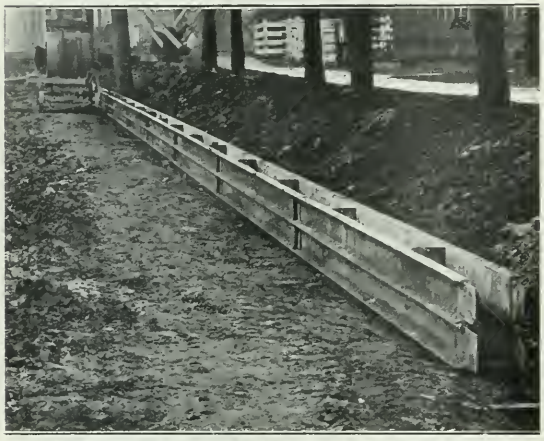
"Strikes for wide construction, 20 ft. or more, require a man at each curb and at each quarter to assist in pulling the strike forward by means of light iron rods hooked to the strike. The general method is to pull it slowly forward and at the same time work it transversely back and forth with a sawing motion. This must be repeated a number of times to produce satisfactory results.

"The finishing of the road or pavement by hand is a delicate operation. More concrete surfaces have been ruined by inefficient handling of floats and trowels than any other way. Floating must be done from a bridge, as the depression left by plank laid on the soft concrete or the track of the workman will be floated full of soft material by the finisher, and depression will result.



BUSH AVE., BELLEVILLE, ILL. 27 FT. WIDE, REINFORCED WITH KAHN MESH. ARMOR PLATES AT INTERVALS OF 34 FT. REED BROS., CONTRACTORS; W. C. WOLFE, CITY ENGINEER.

"The purpose of floating is to smooth out any unevenness which may appear after the strike has passed over it. Hand floating is expensive and a source of constant annoyance to the contractor, who usually cannot get finishers sufficiently skilled to produce a smooth, even surface. To overcome their difficulties and to permit the making of a more perfect wearing surface than could heretofore be obtained, we operate a Baker Automatic Finishing Machine.



CURB FORM SET UP READY FOR POURING CONCRETE. THESE FORMS MAY ALSO BE USED FOR COMBINED CURB AND GUTTER OR AS SIDE FORMS FOR ROAD.

"Perhaps a better idea of the advantages of this machine can be drawn by means of a comparison between the hand and machine methods of finishing. First, consider the merit and concrete requirements of the old method (hand strike and finish):

1. A very wet and even sloppy consistency of concrete is usually maintained in an attempt to force the filling of the voids. This leaves many weakening invisible pores, increasing the possibility of high moisture content.

2. A very wet mix is necessary to provide sufficient time for tamping, striking and floating before the initial set takes place.

3. The wet mix, when used, produces a wavy surface, especially on grades, the tendency being for the mortar to creep away from the crown to the sides or bottom, leaving a flattening effect. This is contrary to specifications, but is unavoidable with a wet mix. Most specifications require a concrete to be so plastic that it will flush readily under light tamping and at the same time be so dense that there will be no separation of the mortar from the aggregate. This is inconsistent. One condition or the other must prevail.

4. Hand striking and floating is slow, tedious and expensive work, requiring at least four or five men for this part of the work.

5. Inability to finish the surface as fast as the concrete is placed on the sub-grade very often results in the necessity of retempering the surface for smooth finishing. This retempering, resorted to after the concrete has started to set, very often destroys the bonding characteristic of the cement and causes rapid wear and dusting on the surface.

6. Hand floating leaves a deceiving surface. It may appear to be smooth, but the presence of numerous small depressions is discernible upon the evaporation of the water. Quite often, while the floating is being done, these depressions are replenished with a little additonal concrete or mortar. This does not leave a proper bond between the depression already floated and the added material, which is liable to form a crust.

7. In hand tamping, as usually performed in conjunction with the striking, the compressive force can only be applied to a very small surface at a time. As soon as the tamp or strike is raised, the mortar and excess water rush into the depression formed, leaving a surface which is not uniform in consistency.

8. The principal reason for advocating a wet mix is that no tamping will be necessary, and consequently the workmen will not be compelled to walk on the concrete. The advocacy also implies that the weight of the material and fluidity of the mortar will furnish the required density.

9. The placing of an excessive amount of concrete results in the riding of the strike and increases the labor in floating and the attending chance for surface waves.

10. To secure satisfactory results, the operation of the strike must be repeated at least two or three times over the entire area.

11. The attempt to secure a hard surface is often made at the sacrifice of a true crown, the tendency being to rub the material out until the surface is flat.

Conclusions to be drawn from the abuses of the hand striking and floating method lead in most cases to faults due to the very wet mix used and to the element of human labor. If these conclusions are correct, then why should we refuse to believe that any other method of performing this work, after the two faults mentioned have been removed, is likewise improper? From careful observation I have drawn the following conclusions on the advantages to be secured by use of a mechanical means of finishing and striking the concrete:

CURB MADE WITH WELL-ALIGNED, RIGIDLY-HELD FORMS.

1. It is entirely unnecessary to use a wet mix; in fact, a more dry mix is very advisable. This will greatly increase the ultimate strength of the concrete.

2. It is not necessary to increase the water content to our roads in 30-ft. sections between the joints and the total, allow

sufficient time for striking and floating. Instead of waiting for the finishers to catch up, the machine is waiting for more concrete. We have only been able to lay 600 linear ft. of roadway per day, and consequently do not know what the real capacity for work of the machine would be. However, it is safe to place this figure at from 900 to 1,000 ft. per day.

3. Waves in the surface are dispensed with. The strike moves transversely and leaves just enough excess concrete for compression to the final grade. The compression pan is placed at a slight angle to permit a more uniform and gradual compression on the concrete. The material under the pan at all sections receives the vibrated compression for a period of about one minute, and more if desired. After the pan has passed any section there are three noticeable features apparent at once, (a) none of the coarse aggregate is exposed at the surface; (b) there are no collections of water on the surface; (c) just enough excess mortar has been brought to the surface to provide a smooth, strong, impervious covering. The surface is left in an ideal condition for the finishing float which follows. After the completion of the float's work, the appearance of the surface is self-evidence of the completeness of the task. Not a wave in the surface, a perfect crown across the entire width and no exposed aggregate.

4. Compare the cost itself of striking and floating with that involved in the other method. The hand method requires at least four or five men. By the use of the machine, only one attendant is necessary, and it might be added that the only necessary qualification he must possess is a willingness to take an interest in the work. Any man who can operate a gasoline engine can operate a Baker Finishing Machine.

5. Possibility of speedy work removes the possibility of having to resort to the abuse of retempering.

6. The vibrative compressive force takes place over a wide section, and there is no flow of mortar into a section previously compressed.

7. A wet mix dispenses with tamping, but weakens the concrete. On a more dry mix the machine produces this tamping, resulting a very dense concrete, free from practically all air bubbles and seepage voids, without a separation of the mortar and aggregate.

8. It is impossible for the machine to ride the concrete, the trucks being fitted with bracket scrapers mounted ahead of the wheels to keep the rails clean. Consequently, there is no tipped effect, and the road must be down to the proper grade across the entire cross section.

9. Only one forward operation is necessary for thoro completion of the work. Machine has no reverse speeds.

10. The vibration produced is crystalline in effect, leaving a surface that is hard, smooth, dense and impervious. The finished work is practically monolithic in structure.

11. No appreciable time elapses between striking and floating, as occurs in the old method. From the time any section has been subjected to striking until it is floated and completed but 2½ minutes have elapsed.

The Belt Finish

Finishing the surface of a concrete pavement by means of a belt drawn across the pavement with a sawlike motion, instead of by the customary methods of wooden hand floats, has given most satisfactory results in Utah. At first there was some hesitation in using this method on wide city streets. It was thought that a belt 30 ft. in width or over would be difficult to handle. Nothwithstanding this doubt, J. M. Tracey, City Engineer of Ogden, determined to experiment with the belt method on Van Buren avenue, a street then being paved with concrete, 49 ft. between gutter lines. The belt was of canvas, 51 ft. long and 12 in. wide. With the exception of lifting and removing the belt from one place to another, two men were able to handle it almost as easily and with equally as good results as on slabs of much narrower width. The process of lifting to remove the long belt was made comparatively easy by utilizing the bridge.

Levi Muir, Assistant Engineer of the Utah State Road Department, applied the same method later, using two 15-in. belts, one leather and the other canvas faced with rubber. In the beginning the leather belt was drawn over the surface, and an additional smoothness was given by drawing the rubber side of the canvas belt along the work. After numerous trials the leather belt was abandoned, and only the rubber-faced canvas one was used.

McKINLEY PLACE, GROSSE POINT, MICH. MASON L. BROWN, ENGINEER; MYERS & LABADIE, CONTRACTORS. A TWO-COURSE CONCRETE PAVEMENT, SHOWING TRUS-CON ARMOR PLATES IN POSITION READY FOR CONCRETE. THESE HAVE BEEN PROPERLY PLACED WITH THE TRUS-CON INSTALLING DEVICE, WHICH ASSURES ABSOLUTE ACCURACY

TRENCH AND TUNNEL EXCAVATION

By J. F. Springer, New York City.

(Continued from July Issue.)

The removal of material from the excavation may be accomplished by the shovel. Indeed, the shovel may frequently be used whatever the dimensions of the ditch, the hindrance to general application coming more from the crowding of cross braces rather than from the depth. If the depth is more than 8 feet, a stage may be arranged at a convenient level. Upon this platform, men in the bottom of the trench throw material. One or more men on the stage, then throw the material up to one side of the ditch or perhaps to a second stage at a higher level. A recommended arrangement is to use two men at the bottom of the excavation to throw onto the stage, one man at either end. Then one man on the stage may at times be sufficient to keep it clear. The stage may extend across the full width of the trench or not. A location of about 6 feet below the surface may often be found convenient for the stage. If the trench is quite wide, it may be found desirable to narrow the stage in order to make it possible for material dug between its ends to be thrown directly onto it. Where stages are arranged at several levels, they should be located about 6 feet apart, vertically, or even at somewhat less intervals. However, the men in the bottom can throw material up to a stage 8 feet above them. It is advised that round pointed shovels be used at the bottom of the trench and square edged ones on the stages.

Material On One Side.

The bulk of the excavated material should be placed on one side of trench and on one side only. However, if traffic conditions permit, it will often be found desirable perhaps to separate the turf or paving removed at the time of opening up the trench and pile it by itself on the side not used to receive the bulk of the excavated material.

Excavated material may often be advantageously removed from the bottom of the trench by the use of grab buckets. In fact, as such buckets are often capable of securing their own load from unloosened material, they may at such times be used to dig as well as remove. With them, we get rid of platforms as the material is at once lifted the full height. The bucket may be operated by a derrick, a locomotive crane or a hoisting plant arranged on a skid. Or, a cableway may be stretched along and over the site of the ditch and the bucket operated from it. In this case, special provision will have to be made for getting the loaded bucket off to the side. Or, the bucket may be operated by a hoisting engine set up back of one of the banks and controlling a rope running over a sheave in a kind of head frame arranged over the trench opening. This head frame may be made movable. Thus it may set on wheels which in turn rest on an improvised track; or the head frame may now and again be jacked up and shoved forward on rollers; or it may be arranged on runners, the forward movement being gotten by means of a winch and a rope or chain.

All the foregoing methods are such as to be applicable either by the use of ordinary tools and rigging capable of being constructed by the contractor or else by the employment of equipment in ordinary use by general contractors on other, than sewers and water main trenching. In addition to these methods, there are others whose application requires the use of specialized equipment—that is, of mechanical devices especially designed for trench excavation. I have scarcely space in this present article to do justice to these. They are to be treated separately.

Use of the Drill.

In the excavation of sewer and water main trenches, *rock* is often encountered. By rock is meant material incapable of being dealt with by ordinary methods. To follow the lines of a model specification, rock consists of boulders having a volume larger than ½ cubic yard of such solid ledge that its removal will require "drilling and blasting or wedging or sledging or barring." A boulder of ½ cubic yard size would weigh somewhere around half a ton. Accordingly, it requires blasting or else the use of handling apparatus, such as a steam shovel or a grab bucket.

Drilling will be done either by hand or by the use of a special machine. There are at least two principal types of power driven drills. The one may be styled the *percussion drill.* Its distinguishing feature is alluded to in this name. The drill itself is made to strike the rock, the advance being largely due to the impact of the moving drill. Such drills are often, not to say usually, mounted on tripods. The operation is by steam or compressed air. These machines, when mounted on tripods, require considerable room, making it difficult to drive holes close up to the walls of a trench. Their use is, accordingly, more advantageous where the trench is to be wide enough to justify the machine for the central holes. However, the percussion drill may be mounted on a *quarry bar* —that is, on a horizontal bar held in position by two pairs of weighted saw-buck legs. With this arrangement, holes may be driven fairly close up to the wall.

There is a third method of mounting—this makes use of the *mining column,* which permits, when usable, the hole to be driven at any angle or even vertically overhead. Its use will often be advantageous where the sewer or water main is to be laid in a tunneled excavation. If the excavation here is to be of small diameter, steam may prove unsuitable.

Types of Power-Driven Apparatus.

The percussion drill is sometimes operated by means of a portable electric motor and a *flexible shaft.* Still another form of percussion drill is that which is operated electrically upon the *solenoid* principle. "The drill is mounted on a tripod, and it differs very little in appearance from an ordinary air-drill. The absence of motor, rheostats, starting box, cranks, shafts, gears, cams, packed joints, close fits, stuffing boxes, and exhausts is always appreciated in coming in contact with this machine." This quotation is from Charles Prelini, an authority on excavation methods. When driving deep holes by the percussion method, it is usual to start with a hole larger than that desired and to diminish the diameter at intervals. This precaution serves to provide against the drill binding in the hole.

Another type of power-driven apparatus is the *hammer drill.* It differs fundamentally from the percussion drill in that the drill has no motion parallel to the axis of the hole. It rests, or is held, against the bottom of the hole and a blow is struck upon its other end by a power-driven ram or piston. This is a wonderfully compact machine, occupying but little more room than a crow bar. One man operates it, unless perhaps when it is used in certain difficult situations. With his right hand he grasps a handle similar to that used on a short-handled shovel and with his left takes hold of the handle of a wrench set horizontally on the drill. The compressed air, supplied by a flexible hose, enters the machine just beneath his right hand and secures the up-and-down movement of the piston or ram. A tube carries part or all of the exhaust air down to a position where it is directed so as to serve the purpose of keeping the hole clear. As the strokes are made, the operator turns the wrench in a horizontal plane, ⅛ of a

turn at a time being good practice. This serves to keep the bottom of the hole level, upon which the straightness of the hole probably largely depends. A power hammer drill capable of driving holes with a diameter of 1½ inches weighs 25 pounds. One driving a hole 2 inches in diameter weighs but 35 pounds. The hose required is quite small, having a diameter of only 7/16 or ½ inch.

In limestone (oolithic), varying in its hardness and being very irregular, a dozen drills of the smaller size produced an average record of 4 holes per drill, each hole 18 inches deep, in a shift of 10 hours. One machine drilled 36 holes, each 42 inches deep, in 7 hours. These drills seem exceedingly well-adapted for trench work. The diameters mentioned above refer to maximum sizes and not to the diminished sizes at the bottoms of deep holes. This must be borne in mind when considering the usable diameter of explosives. At the bottom of 3-foot holes made by the smaller drill, ⅞-inch powder may be used; by the larger drill, 1¼-inch powder.

The Use of Explosives.

Whatever method is used to make the holes, once the latter are drilled, it makes little or no difference. Dynamite is a favorite explosive with which to do the blasting. However, in trench work, "gunpowder, or black powder, and contractor's powder are sometimes used, especially for breaking down frozen earth, for quarrying stone, which may be readily split out and for cracking boulders and large pieces of ledge rock." The engineer or contractor must expect to use larger quantities of explosives in trench and tunnel work than in ordinary quarrying or even in surface blasting. One principal reason is that the rock is more securely held in the ledge—there is only one face with which to deal, and the rock is held in all other directions.

I have scarcely space to deal in detail with blasting. Consequently, I must confine myself to some of the principal matters. In trenches, the holes are ordinarily spaced about a yard apart, whether we look along the axis or across the trench. If the width of the trench is just 3 feet, there will ordinarily be two holes abreast, one on either side. Prof. Ogden says that he has "in soft limestone, for trenches for 6-inch pipe not over 8 feet deep, particularly when only the bottom of the trench was in rock, put down a single row of holes in the middle of the trench; but a large amount of picking and hammering is always necessary to finish up the work. In sedimentary rock in thin layers, or when a thick layer comes just above the excavation bottom, it is only necessary to drill the blast holes to the bottom of the desired trench. But in tough granites and thick, hard limestones with strata disadvantageously placed, it is frequently necessary to drill 1 foot below the trench bottom in order to have every point of the bottom at least 6 inches below the pipe."

The Stationary Compressor.

Sometimes it will be preferred to use a stationary compressor. In this case, it will be necessary to pipe the air to the point of use. Now compressed air is no exception to the general rule that we lose a percentage of energy when we transmit power. This is the case with electric current, with steam, etc. The only question that need concern us is whether the loss with compressed air is an uneconomical one, as compared with other alternatives. Let it be understood at once then that compressed air may be transmitted with small loss of pressure (tension), provided the original pressure and the pipe diameter are suitable to the case in hand. There are three principal factors governing the loss of pressure from friction in transmission. These are: (1) The initial pressure, (2) the length of the pipe line, and (3) the diameter of the pipe. Apparently, the pressure loss is proportional to the length of pipe; so that, if we can learn its amount in any given case for 100 feet, we can at once determine its amount for the whole line. The matter is, so it seems, more complicated when considered in connection with variations of initial pressure and of pipe diameter. Thus, the variation of the size of the pipe from 1 to 2 inches, 100 cubic feet of free air being the volume in question, 100 feet the length of the pipe, and 90 pounds the initial pressure, is responsible for a change in the loss from 5.19 pounds per square inch to 0.12 pound. This is a very great relative difference, even after taking into account the relative change in contacting surface. Consider another case: Let the initial pressure be 100 pounds, the length of pipe 100 feet, and the quantity of air 2,000 cubic feet. With a 4-inch pipe, the loss of pressure will be 1.13 pounds per square inch; and with an 8-inch pipe, only 0.03 pound. These examples are sufficient, perhaps, to make us alive to the *enormous advantage* of a large size pipe. Even a small increase in the pipe diameter is competent to effect a considerable reduction in the pressure loss. Thus, in the last illustration, suppose that instead of making the jump from the 4-inch pipe to the 8-inch, we simply make the very moderate increase to the 5-inch size. The loss in pressure drops from 1.13 pounds per square inch to 0.36 pound. Consider now the effect of varying the initial pressure. Let the amount of air in question be 1,000 cubic feet, the length of the line 100 feet, the diameter of the pipe 3 inches. If we have an initial pressure of 100 pounds under these conditions, the pressure loss due to friction is 1.25 pounds per square inch. If the initial pressure is 10 per cent. less—that is, 90 pounds—then the pressure loss is 1.39 pounds. We may learn from this that, other things being equal, the higher the initial pressure, the less the pressure loss. The variation in pressure loss is quite moderate. Take another case. Let the amount of air be 2,000 cubic feet, the length of line 100 feet and the pipe diameter 10 inches. For 100 pounds initial pressure, the loss is 0.01 pound per square inch for 90 pounds, it is tabulated the same—that is, 0.01 pound. Possibly there is a slight difference, too small to make a show in the tables. Take a case of a smaller quantity of air, say, 100 cubic feet. Let the pipe line be 100 feet long and the diameter 1¼ inches. Corresponding to initial pressures of 100 and 90 pounds, we have losses of 1.3 and 1.44 pounds, respectively. We learn then that the initial pressure plays a very modest part. Probably the additional cost involved in producing 100 pounds pressure instead of 90 pounds will more than offset the moderate loss of pressure, unless we have some necessity demanding the higher pressure. The thing to fix one's attention upon is the *pipe diameter*. This plays an important part. Coupled with the length of line, the total loss may be quite serious.

It has been pointed out elsewhere that the loss of pressure from friction in transmission is not so serious as one's first consideration might lead him to think. The loss in pressure is somewhat offset by the fact that we have a gain in air with which to work. A thousand cubic feet of free air is compressed so as to have a pressure of 100 pounds will have a certain volume. This volume will be less than if the same amount had been compressed so as to have a pressure of 98 pounds.

It is naturally important, however, to make sure that *at the working point* we have the pressure needed and a trifle to spare.

In constructing sewers, water mains and the like, it will at times be necessary to provide against the settlement of nearby structures. Occasionally, even structures at some distance may be affected by the excavation—as when a stratum of quicksand is released by the trench or tunnel in cases where the confinement of the sand is necessary to the stability of buildings built anywhere upon it. Even the unwatering of an excavation may adversely affect the support of buildings some little distance off. As a rule, however, it is the building close at hand that demands our attention. Our excavation may pass beneath a corner or beneath one side of a wall. That is to say, the carrying on of the excavation

operations may involve us in *underpinning* the foundations of certain buildings. I shall not take up space here in detailing old methods, but will call attention to the modern system of underpinning with the aid of a concrete pipe encased in a steel sheath. This system has been put to extensive use in New York City in connection with the new subways now under construction. William Street, for example, is occupied beneath the surface for a large part of its length by the excavation of a subway tube. Tall buildings have their foundations—or perhaps it would be better to say, the support of their foundations—more or less trespassed upon from below. Great underpinning operations have been required in this and other neighboring regions. I propose to give a brief account of a successful method used on William street.

Concrete-Steel Piles.

The concrete-steel piles are about 14 inches in diameter. The sheath consists of section after section of steel tubing of thin material. First the sheath is put down. Then it is cleaned out. The concrete is then poured into it and the pile is completed. Such piles may stand in a double row beneath the foundation of a building wall along one side of the street. Their heads will not reach quite to the foundation, a heavy mass of concrete being interposed. Let me explain how such piles may be driven and formed beneath the foundation and how the mass of concrete is put in place, despite the fact that both this and the piles must at some stage of construction be loaded with the great weight above.

One of the first things to do is to get underneath the foundation. This is done by very small sections at a time, although a wall may be undermined at several separated points simultaneously. Great care has to be taken. It may be necessary to open up even the small section a bit at a time, the excavation waiting until the bit of exposed under surface is supported. However, suppose that a pit has been dug alongside the concrete slab on which a row of footings rest. This pit may be extended cautiously beneath the slab until enough space has been gotten to accommodate a pile or two. We may then drive these piles.

The sheath is driven down by means of a hydraulic jack. First, the bottom section of tubing will be set up on the floor of the pit. This will then be driven by a jack reacting against the under surface of the concrete slab forming the ultimate foundation. It may be necessary to do more or less blocking up in order to cover the full vertical space. When one section has been forced into the soil, another is set upon it and both together as a single unit are jacked down. One section fits into another much as a spigot end fits into a bell. The procedure of lengthening the sheath is continued until the required penetration is accomplished. The cleaning out may now be done. For this purpose, at least in some situations, a diminutive orange peel grab bucket has been found suitable. This bucket may be weighted, if necessary, to give it digging power. A kind of screw or auger may be employed, where it seems more suitable. When the cleaning out has been completed, concrete is filled in. If the foot of the sheath has reached and fairly entered an impervious stratum, it may be possible perhaps to clear the tube of water. Otherwise, we may have to deposit the concrete through the water. It should upon no account be dumped in and allowed to fall through the water. Such a procedure would likely disintegrate the concrete more or less. A bottom-dump bucket may be useful. I am not aware that a tremie has been employed in this work, but there seems no reason why it should not be used, as the underwater placing of concrete by the tremie has lately reached an approved position in practice. I am referring now to the best methods. When the concrete has reached about the top of the sheath, we put in place a metal cap which covers concrete and sheath, the central portion of the cap extending an inch or so down into the sheath. The object of the downward projecting portion is to put pressure on the concrete before it comes on the sheath. The jack is rigged above the cap so as to have reaction against the foundation, as before when driving the sheath. We now force the whole pile until the resistance and behavior are satisfactory.

The jack is now carrying the load and the pile is supporting the jack. The problem that now engages attention is the relief of the jack in order to permit its removal. This problem is solved by putting two I-beams in vertical position on the cap, these beams reaching from cap to within a trifle of the foundation. Wedges are now driven in the space at the top of the beams until the load has been transferred, as perfectly as may be, to the beams. Naturally, the wedging procedure will fall somewhat short of a complete transfer of load. This will become apparent, upon the release of the jack, by a slight rise of the pile. It is considered quite important to reduce this reaction of the pile to as small an amount as possible. In fact, no reaction at all is what is wanted, in order that no disturbance of conditions at the foot of the pile may enter. So far as I am informed, however, no method has been put into use which effects a total elimination of the rebound. We will suppose now that we have put in and wedged to a satisfactory degree all the piles we propose to put in the small section of excavation beneath the foundation. We may now place suitable planks and concrete the pit beneath the slab or other ultimate foundation. This concrete will, of course, envelop and imbed in itself the I-beam uprights.

It may be necessary to unite footings above a foundation slab in order to prevent independent settlement. One method of doing this is to set short lengths of I-beams in such way as to make criss-cross work, each length reaching obliquely from one footing to the other. If these are properly set in niches cut for them and the whole concreted, we get a kind of inverted arch.

Methods of Tunneling.

Tunneling is apt to be expensive. It is nevertheless at times quite necessary and may be more economical than trenching because of the depth of overlying material. It is usual by ordinary methods to protect the excavation from cave-ins and the like by the use of timbering. Recently, however, a method has been developed and used on important work in which timbering is partially or entirely eliminated. The method is, unfortunately, not everywhere applicable. By this procedure, the excavation of the arch is closely followed by the construction of a concrete arching. As soon as the centering is removed, this arch of concrete takes care of the overhead strata without timbering and without other obstruction of the tunnel. The further prosecution of the excavation is facilitated because of the access to the heading, especially where any arch forms that may be in place are constructed forms of the sides of the excavation which afford support for the arch may or may not be cut away for the substitution of concrete side walls in the space thus left vacant. In case the exchange from rock to concrete is necessary, it will naturally be carried out piecemeal. A certain amount of timbering may be needed to sustain the arch during this procedure.

Where the tunnel passes through water bearing strata, compressed air and the shield may be employed, provided the hydrostatic head is not too great. The limitation arises, not from any inability of compressed air to exclude water, whatever the pressure behind it, but from the fact that the men doing the actual excavation—the "sand hogs"—can not live and work in an atmosphere whose pressure (tension), much exceeds 45 pounds per square inch. Where the tunnel passes beneath a river or arm of the sea, another limitation may enter. As the air in the tunnel heading presses in every direction with full force, it is necessary that the resistance overhead shall be sufficiently stable. Otherwise, the air will find a line of weak resistance and a "blow out" will occur.

Such "blow outs" have occured at New York in the subaqueous excavation of recent years. They may sometimes be successfully combatted by covering the areas of weakness with clay blankets.

Tunnels excavated with the aid of compressed air and the shield are usually lined with rings of cast iron or wood placed in position one after another to form a circular shell. The individual rings will consist of segments. The shield is advanced, from time to time, by means of jacks pressing against the exposed annular and plane surface of the last ring put in place. The "tail" of the shield, as the rear part of the cylindrical shell of metal is called which is every now and then forced ahead, envelops one or two rings. When the jacks have been withdrawn after an advance, there is a clear space in the tail where a new ring may be assembled. At Worcester, Mass., a certain amount of 6-foot sewer construction was done by shield and compressed air. *Wooden blocks* were employed for the lining.

The Lawrence Avenue Sewer at Chicago is an example of tunneling during which the shield was employed. It is not always necessary to use compressed air with the shield. Whether it is to be used or not will turn largely on the amount and pressure of the water encountered. The pressure to be used may have to be a compromise. If the full pressure necessary to keep water from entering the bottom of the excavation is used, then the pressure may be sufficient to render the operations subject to "blow outs"; if only enough pressure is used to exclude water perfectly from the extreme part of the excavation, then the bottom may become soft and the shield difficult to manage in consequence. The pneumatic method is not to be regarded as inexpensive. But it is a pretty sure procedure, when used in its proper field of activity.

Care of Drill Bits.

Of great practical importance in rock excavation are the character and care of the drill bits employed. Solid bar steel is employed in *percussive* drilling, and hollow bar in *hammer* drilling. The external outline of the cross-section may be circular, hexagonal, octagonal or cruciform. The Germans use a twisted bar on whose end a kind of Z-shaped cutting face may be formed. The cutting face of American drills usually consists of edges radiating from a center. There may be half a dozen of such edges and there may be only two. In the latter case, the two edges being 180 degrees from each other, we have simply a single cutting edge forming a diameter. If the cutting edges all lie in one plane, then we have a "square" edged bit. Such a type is suitable for use *after* the hole has been well started. For *beginning* the hole, however, a bit whose edges form a convex cutting face is understood to be very effective, the convexity biting into the rock. On the other hand, this type seems to be liable to the formation of crooked holes, if the rock is seamed, the bit seeking to follow crevices. The cutting face will occupy a larger gross area than the cross-section of the shank. This secures ease of movement.

The care of the bit is very important indeed, especially the heat treatment termed hardening and tempering. The precise temperature to which a drill bit should be heated for hardening will depend largely upon the character of the steel used. The maker of the drill rod should be able to supply accurate information upon this point, in respect to his own steel. A good deal depends, however, upon the quenching. It is understood that the common method is wrong—that ordinarily the bit is immersed to too great a depth. The outer, comparatively thin parts of the bit will cool faster than the center. The blacksmith is apt to take the bit out, so it seems to be thought, before the central part has cooled. Sometimes, the attempt will be made to harden with the heat used for forging. It is recommended that the drill bit be hardened by dipping it vertically into ¾ inch of gently flowing water. It is important that the drill be vertical, as otherwise one side will be hardened further back from the face than another. After hardening, the usual carbon steels should be tempered at the temperature suited to the circumstances. The bit should then be sharpened. In by-gone times, it was usual to do this by hand, but today it is possible to use a special machine adapted to sharpen to precise form and size. Mr. M. Gault, at one time superintendent of sewers in one of the New England cities, is reported as stating that the cost of drill sharpening had been reduced to one-third the previous cost by the use of a special machine. The work is probably much more accurately done in addition. It is understood, among other things, that the cutting edges should present right angles.

Use of Special Braces.

The special braces which have been designed are of several varieties. Some are entirely of metal; others are partly of wood. Generally, the brace is lengthened or shortened at one end only. The extending and contracting will ordinarily be accomplished by turning a threaded rod in a strut provided with an internal thread or *vice versa*. It will be possible to go along the trench and tighten or loosen the braces as circumstances may require. With the object of keeping the strut itself horizontal and at the same time providing a bearing surface more or less inclined to the vertical, ball and socket joints have been employed. Complaint has been made, it appears, of considerable breakage with such joints. It is understood that this breakage is mainly due to unevenness of fit in the joint, the convex and concave surfaces not being machined. If this objection is well founded, it ought to be possible to meet it without much difficulty or extra expense. Undoubtedly, such surface could be readily ground to form and size by a special grinding machine. The grinding would not need to be carried to any high degree of precision.

Whatever type of brace is used, lugs should be arranged at both ends to provide against the brace falling down upon the workmen in case it is accidentally loosened or in case the earth yields back of the sheeting.

Sheeting of wood or steel may often be driven by a wooden maul. Such an implement may weigh upwards of 25 pounds. The wood of the head should be held by rings or bands of steel or by an equivalent. Naturally, one sets the bands so as not to interfere with the blow. The bands should be secured firmly in place, say, by the use of wedges and pins. The handle should not be round. A hammer or pick handle is suitable.

A hammer of, say, 16 pounds weight is needed for shifting and otherwise dealing with the braces. The head may advantageously have two opposite striking faces that are perfectly flat. Altogether, the head may resemble a spool of thread—that is, it may be a cylinder with flat bases provided with ridges back of the faces. It is understood that hammer of this description is more suitable for working with braces than is the ordinary sledge.

For considerable information contained in this article the author is indebted to the Harold L. Bond Company, E. I. Du Pont de Nemours Powder Company, Wemlinger Steel Piling Company, Sullivan Machinery Company and the Ingersoll-Rand Company.

Joint Leakage in Vitrified Pipe Line

By William W. Brush, Deputy Chief Engineer, Department of Water Supply, Gas and Electricity, of New York City.

The Boro of Richmond had an inadequate and unsatisfactory water supply prior to the introduction of the Catskill water, which was made effective in January, 1917. The average daily consumption in the Boro of Richmond is twelve million gallons. To meet the growth in consumption and to lower the overdraft at existing stations, an additional supply of some six million gallons daily was planned as far back as 1910. A driven well system was to be established along what is known as Southfield Boulevard, a broad public highway running along the southeasterly side of Staten Island. The carrying out of this plan was delayed by various causes, and the new development was not completed sufficiently to be utilized until the spring of 1915.

THE department proposed to construct the entire collecting line of cast iron pipe, bnt owing to the short period that would probably elapse between the completion of the development and the introduction of the Catskill water, it was necessary to reduce the construction cost to a minimum. The utilization of an existing distribntion main, which was not immediately required to deliver water, satisfactorily solved the problem of a collecting line for the southwesterly section. The substitution of 18-in. vitrified pipe for 16-in. cast iron pipe for the northeasterly section rednced the estimated cost for same from $27,000 to $20,000. At the time of the substitntion of vitrified pipe for cast iron pipe, as recommended, Mr. I. M. deVarona, then chief engineer of the bureau, noted that a risk was taken of excessive leakage, bnt, based upon previous experiments, it was concluded that the joints could be made sufficiently water-tight to permit the pipe line to satisfactorily serve its pnrpose. There was no fear of the pipe itself being of insufficient strength to withstand the pressnre, which was estimated at a maximum, under working conditions, of abont 5 lbs. per sqnare inch.

The pipe was to be laid to grade on the bottom of the trench, except where the earth would not properly support the pipe, when either timber or concrete supports were to be furnished.

The cold weather interfered with the work, as did also the water in the trench, due to the ground water level being above the pipe invert between the main station and station No. 3. The contractor selected for the joint compound an asphaltic mixture known as "Filtite A," which was the material previously used in tests made by the bureau and which had been successfully used in sewer work in Brooklyn.

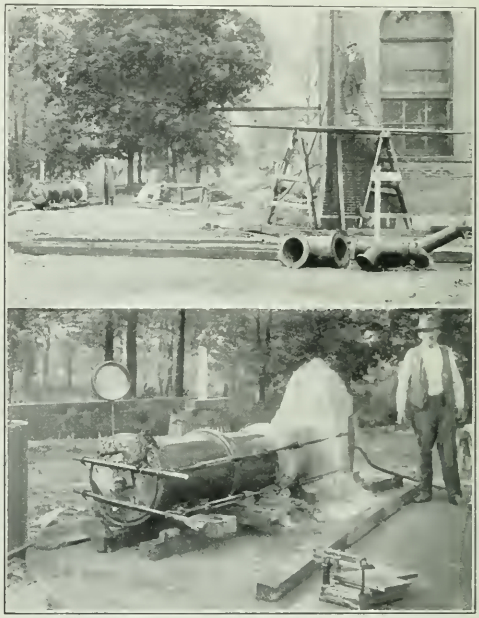
Leakage at Joints

When the laying of the pipe had been completed, the infiltration of ground water was noticed. The flow was gaged at the central pump well in the latter part of February, and early in March, and found to average during a three-day test 13,170 gals. per 24 hours. This was equivalent to 163 gals. per joint per 24 hours. The seepage indicated that some leaks would be fonnd.

On April 7 this line was placed under test, the head being about the working head, and at 22 points between stations 54-13 and stations 66-74, a distance of 1,261 ft., water showed on the surface. Here the boulevard is a fill over a swamp and the foundation for the pipe is consequently somewhat unstable. When the leaky joints were examined the conditions disclosed might be described under these three heads:

First—Where a separation existed between the joint compound and the barrel of the pipe or between the joint compound and the hub. This separation varied from the merest hair-line opening to an amount which would admit the passage of a knife blade.

Second—Where the joint compound had started to blow out, in general more at the bottom of the pipe than at the top, varying from the merest indication of starting to cases where pieces of the compound were ready to fall ont.



TESTING PIPE JOINT COMPOUND WITH HYDROSTATIC PRESSURE. LOWER VIEW SHOWS PIPE WHICH BURST UNDER 40 POUNDS PRESSURE.

Third—Where the joint at the bottom was entirely blown out. In some cases the pieces of joint material were thrown out by the laborers in excavating, and in one or two cases I found pieces of the compound in the mnd upon searching aronnd with my hands. It is quite evident that this joint compound does not adhere to the glazed surface of the pipe under service conditions. While a thin film of the compound, when poured over a very clean place on the pipe, seems to adhere, a considerable thickness of the material, as in the case of the joint, does not.

Contractor Made Repairs

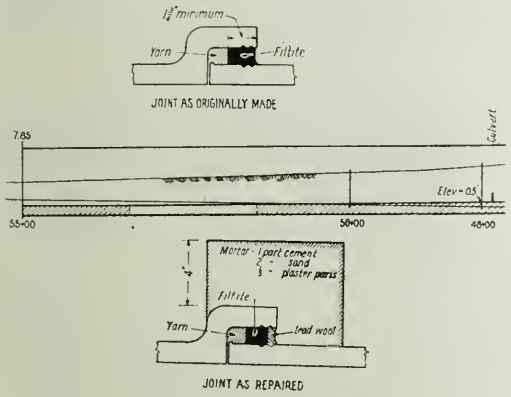
On April 14 the contractor had re-run the leaking joints, and on April 15 the pipe was again subjected to test by operating both pumps in Station 4 (the most easterly one). Fifteen leaks developed on this test. After a discussion as to the responsibility of the contractor to repair all leaks, under a clause which required a year's guarantee of all the work, he

made the repairs, beginning June 4, finding 58 joints to be replaced.

Leaks have continued on this line since then up to the shutting down of the plant in February, the record being as follows:

	1915	1916	1917
January	..	19	4
February	..	26	6
March	..	36	..
April	..	10	..
May	..	11	..
June	End of maintenance period by contractor		
July	11	19	..
August	4	36	..
September	4	66	..
October	3	29	..
November	8	6	..
December	..	24	..

The contractor made all his repairs by removing the joint material and re-running the joint. The department men tried various schemes, the most successful being to drive the joint material into the hub, caulk in lead wool, and then place a concrete block around the joint. The repaired joints, in general, did not leak again. Practicall yno trouble was occasioned by split pipe, only one or two being found in the whole line.



TEST OF VITRIFIED PIPE AND JOINTS. PIPE BURST AT PRESSURE OF 40 POUNDS PER SQUARE INCH.

Experimental Tests of Joints

In 1912 the bureau had tested 12-in. vitrified sewer pipe, using the "G. K." compound and "Jointite," which is the predecessor to "Filtite" and practically the same material. This test showed the joint would stand 29 lbs. per square inch. At the same time joints made of plain yarn, with yarn soaked in cement grout and with lead wool, gave very unsatisfactory results. At an earlier date cement joints poured also leaked freely.

After the leaks were discovered, two tests were made, one in the field at Grant City and one at the Portland avenue yard in Brooklyn.

The Grant City test, which is illustrated by the photographs, was as follows:

"Three lengths of vitrified pipe were used in making the test. Pipe No. 1 was a complete hub and spigot pipe which had been condemned on account of an interior blister; spigot end inserted in joint 'A'; about 2 in. of this spigot end was not salt glazed. To the hub end of this pipe was attached the wooden outlet bulkhead.

"Pipe No. 2 was a complete hub and spigot pipe which had been condemned on account of an exterior blister. Hub end of this pipe in joint 'A' completely salt glazed; spigot end in joint 'B' and was completely salt glazed.

"Pipe No. 3 was a hub and spigot pipe, about 3 in. of the spigot end of which had been cut off on account of slight cracks; hub end of this pipe in joint 'B' and was completely salt glazed, and the spigot end was attached to the wooden inlet bulkhead.

"The pipes to be tested were set on a timber grill and rested on wooden wedges to preserve line and level. The wooden bulkheads and the iron tie rod being the same as were used in previous tests at the North Portland avenue yard, Brooklyn.

"On May 19, 1915, work was started on the physical test of the pipe and compound. Joints 'A' and 'B' were caulked with grout-soaked yarn, after which the joint space was thoroly cleaned and dried; the joints were then run with joint compound taken from a new barrel marked 'A-3,' a sample of which was sent to the laboratory on May 18, 1915.

"On May 22, 1915, joint runners were removed from joints at 9 a. m.; joints were carefully examined and found to be good.

"At 10:30 a. m. started filling test pipes with water, air valve open, head 4 ft. Pipes full at 11:05 a. m. and air valve closed at 12:05 p. m.

12:40 p. m. No leakage; head increased to 8 ft.
1:10 p. m. No leakage; head increased to 9 ft.
1:47 p. m. No leakage; head increased to 10 ft.
2:20 p. m. No leakage; head increased to 11 ft.
2:55 p. m. No leakage; head increased to 12 ft.
3:15 p. m. Test suspended due to rain; pressure removed and air valve opened."

The pressure of 12 ft. was again put on May 26 and continued without leakage until May 27, when both joints were leaking. The leakage reduced from a maximum rate for each joint of about 24 gallons per 24 hours to about 10 gallons for one joint and 2 gallons for the other, the test continuing until June 14, when the pressure was slowly raised to 35 lbs., and held there for 35 minutes, with a leakage from one joint of 232 gallons per 24 hours. The pressure was then raised to 40 lbs., when a pipe split.

Description of Test

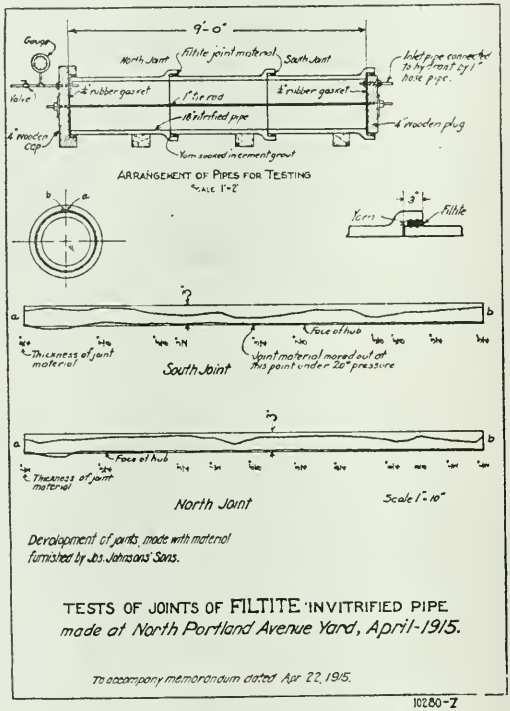
The description of the test at the Portland avenue yard is as follows:

"On account of the failure of a number of joints in the vitrified pipe collecting main in Southfield Boulevard, arrangements were made to set up and test vitrified pipes having joints of the material used in Southfield Boulevard, or material similar thereto. Two test lines, each consisting of three lengths of 18-in. standard deep and wide socket vitrified pipes, with bulkheads at the ends, were set up at the North Portland avenue yard. The arrangement of these test lines is shown on the accompanying print, No. 10,280-Z.

"The joints of one of the test lines were poured with material received from Joseph Johnson's Sons, the contractors for the Southfield Boulevard job, and the test records of this line are shown on Sheet No. 10,279-Z. The joints of the other lines were poured with similar material furnished by the Pacific Flush Tank Company, who furnished to the contractor the material used in Southfield Boulevard.

"The joints were made in accordance with the specifications, a jute gasket dipped into cement grout being used at the back of the joint. The material received from the Pacific Flush Tank Company was first poured. Before pouring, the cement remaining on the surface of the southerly of the two joints in this line was brushed off the pipe, so as to leave the pipe clean. The cement was allowed to remain on the surface of the pipe and spigot of the north joint. It was attempted, as specified for the Southfield Boulevard contract, to pour the

material thru a gate located a little to one side of the top of the pipe, allowing the joint material to flow down and around the pipe and up on the other side. On the joints where the Pacific Flush Tank Company's material was used this was not accomplished, the material flowing both ways from the top of the pipe. On the north joint the clay gasket used to confine the joint material broke thru several times during pouring and



ARRANGEMENT OF JOINT TEST AND DEVELOPMENT OF JOINT MATERIAL.

the time necessarily elapsed between successive pourings while the clay was being repaired. The south joint was provided with a rubber hose gasket and no difficulty from breaking out of the material was encountered.

"On the line in which the contractor's joint material was used, hose was used as a gasket and the joints were poured, as specified, the material flowing from one side only.

On April 21 tests were made of pipes joined with the Flush Tank Company's material, and also that furnished by the contractor. In a 25-minute test of the compound furnished by the former, the initial pressure was 5 pounds, this being gradually increased to 20 pounds. Leakage was serious even at 10 pounds pressure. Caulking was attempted, but was found to have little or no effect in stopping the leakage. Practically the same test was carried out on the pipes joined with material supplied by the contractor. Leakage was less but results were far from satisfactory. Results of this test are shown in a table reproduced on this page.

"The pipe in which the contractors' joint material was used age, the south joint moved out at the bottom, so that no further was then broken and the joints removed for examination. It was found that the south joint, which failed, was deficient in depth at the bottom. The yarn gasket had apparently not been driven back into the socket sufficiently to permit the full depth of the joint to be poured. The remaining joint appeared to be satisfactory.

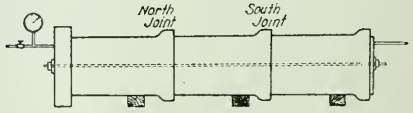
"The north joint in the line, in which the flush tank company's material was used, was then cut out with a cold chisel. This joint was, of course, known to be defective on account of the trouble during pouring. It was found that hollow spaces existed in the joint material.

"There seems, however, to have been no lack of adhesion to the joint, except where the joint had been caulked so that the joint material was broken."

Conclusions

The experimental work and the field results showed that the vitrified pipe would safely stand low pressures, say under 25 lbs. per square inch, that none of the joint compounds were successful in preventing leakage, but that fairly satisfactory results could be obtained by thoroly cleaning the joints before running them. The use of cement-soaked yarn appeared to be detrimental in its effect on water-tightness of the poured joint.

TESTS OF JOINTS OF 'FILTITE' IN VITRIFIED PIPE
made at North Portland Avenue Yard, April-21, 1915.



II *Joint material furnished by Jos. Johnson's Sons.*

TIME	PRESSURE lbs PER □"	LEAKAGE IN GALS PER DAY		LOCATION OF LEAKS	
		No JOINT	SO JOINT	NORTH JOINT	SOUTH JOINT
9:00	0# Pipe Full	Slight Leakage			None
10:27	0# Pipe Full	Slight Leakage	Slight Leakage		
10:35	5#	180	135		
10:39	10#	270	270		
10:45	15#	360	630		
10:50	20#				
10:52	20#		Joint moved out		Forced out here

To accompany memorandum dated Apr 22, 1915.
10279-Z

DATA FROM JOINT TEST ON VITRIFIED PIPE.

The bureau has during the past month been experimenting with caulked cement joints for cast iron pipe, following the instructions given by Mr. Clark H. Shaw, in his paper presented on April 18, 1917, before the American Society of Civil Engineers. These joints have been highly successful under test pressures up to 300 lbs. per square inch. There seems to be no good reason why a caulked cement joint in a vitrified pipe would not be water-tight up to the pressure the pipe would safely stand if care is exercised to caulk only to an amount that the hubs will stand without cracking. Experiments along this line are to be undertaken by the bureau in the near future.

Pavement Problems on New York Bridges

A study of the causes underlying excessive depreciation of pavements on the Queensboro, Williamsburg and Brooklyn bridges, with outline of new paving methods involving use of shallow wood block. From data prepared by Edward A. Byrne, acting chief engineer, Department of Plant and Structures, New York City.

EXCESSIVE vehicular traffic over the more important bridges that span the North river resulted in pavement wear that some time ago made necessary an entire replacement of the roadways. In each case the pavement was redesigned to avoid the weaknesses that had developed with the old methods, when the traffic became too heavy. An exact count made at each of the four principal bridges showed that from 18,304 vehicles in 1912, the number had in 1916 increased to 35,034. Of the 1912 total, 11,893 were horse-drawn and 6,411 motor-driven. In 1916 11,584 were horse-drawn, while the motor-driven vehicles had increased to 23,450, an increase of nearly 300 per cent. in the motor vehicles, while the number of horse-drawn wagons remained practically the same.

Study of Queensboro Bridge

On account of the bad condition of the paving at the Queensboro bridge and the detrimental effect that this bindrance to traffic had on the development of the boro of Queens, this bridge was the first to receive consideration. Funds for the work were provided early in 1916, and in November of that year one-half of the roadway—the southerly half—had been reconstructed and opened to traffic.

The pavement (old type) of the Queensboro bridge consists generally of treated wood blocks on a Portland cement-concrete foundation. This foundation rests on different bases at various sections of the structure. On one approach the base is of reinforced concrete, which in turn supports water-proofing protected by common brick, on which the pavement foundation is laid with a thickness of 6 in. On part of the other approach the concrete foundation, 6 in. thick, rests on earth fill and part on buckle-plate floor. On the main bridge buckle plates ⅜ in. thick support the concrete foundation. Main dimensions are as follows:

Length of the approach on reinforced concrete.1,052 ft.
Length of the approach on earth fill..... 436 ft. 2½ in.
Length of the approach on buckle plates.....2,236 ft.
Length of the main bridge on buckle plates....3,724 ft. 6 in.

Total length of bridge.....7,448 ft. 8½ in.

The width of the roadway is 52 ft. 3 in., which means an area of 43,240 sq. yds. of wood block pavement to be maintained. The pavement laid on reinforced concrete and on earth fill, amounting to 8,640 yds., has not required any repair from the time the roadway was opened to traffic on March 30, 1909. The part laid on buckle plates, 34,600 sq. yds., has been a source of constant trouble during the past 4½ years.

The design of the roadway floor where buckle plates are used called for the placing of these plates on stringers having a top flange width of 12 in., spaced 5 ft. on centers, the plates being laid with the buckle down. On this floor a Portland cement concrete base (1:3:6) was laid. The depth of this foundation, for the greater part of the roadway, varied from 1½ to 4½ in. On this concrete a cushion of very dry cement and sand mortar ½ in. in depth was spread and the blocks were laid at right angles to the center line of the bridge with ⅛ in. joints.

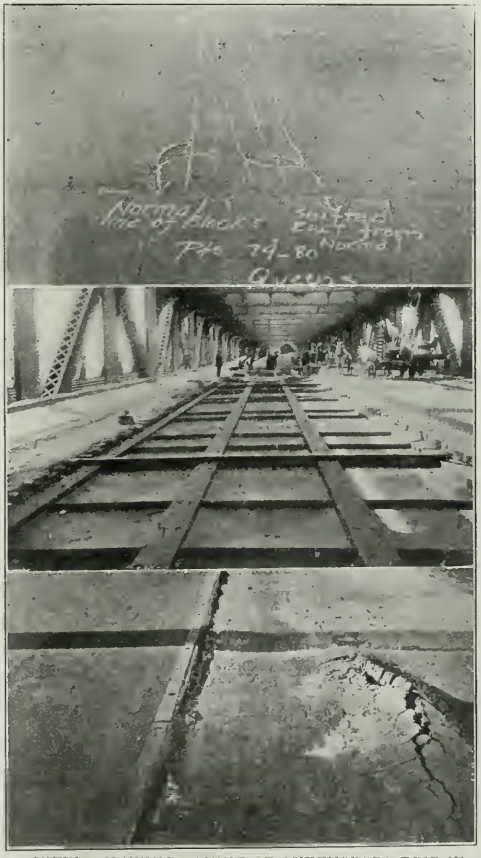
The blocks were 4 in. in depth and cut from sound, long-leaf yellow pine planks 4 in. thick and from 7 to 9 in. wide.

The blocks were treated by the creo-resinate process, and the usual tests were specified.

The joints were filled with paving cement of a bituminous material, free from coal tar or its products.

Poor Drainage Caused Buckling

The Queensboro bridge was opened to traffic in March, 1909, and for the first two years of service this pavement required but slight attention, but the constantly increasing traf-



VIEWS SHOWING PAVING OF QUEENSBORO BRIDGE: 1. OLD BLOCKS SHIFTED 12 INCHES OUT OF LINE; 2. LAYING NEW BLOCKS ON COMPOSITE FOUNDATION; 3. NEW AND OLD WORK SIDE BY SIDE. (BULGE IN OLD PAVEMENT IS 14 INCHES HIGH.)

fic commenced to affect the foundation quite seriously. The buckle plates, under the heavy traffic, continually deflecting, caused the concrete to crack and disintegrate at many points. As the stringers provided a more rigid base, the concrete over them stood up much better.

The concrete used was of very lean proportions for use un-

der such conditions, and it might be justly stated as a further cause why this pavement failed. The sand and cement cushion has also been a source of trouble. This cushion, for lack of ability to drain, is always damp, and after storms it is thoroly saturated. When these storms are followed by rapid changes in temperature, the blocks commence to heave, and this heaving in many places has amounted to over 3 ft. above the normal surface of the pavement. This cushion provides a shifting base for the blocks, and this, together with the expansion and contraction of the bridge, further accelerates the movement of the pavement. At some points the cushion has entirely left its position at the buckle plate and moved to a point over the stringers, and, in doing so, has raised the blocks above the concrete foundation. On one or two occasions vehicular traffic over the bridge had to be confined to the spaces occupied by the trolley tracks to avoid possible accident. There are two trolley tracks laid on this bridge within the pavement limits, each located near the curbs.

New Blocks Without Cushion

A new foundation has been designed by the author, which in general consists essentially of a parquet foundation, formed by a combination of timber planking and Portland cement concrete, with the creosoted wood blocks laid directly on this foundation, without a cushion.

The timber used was long-leaf yellow pine, merchantable inspection, dressed to thickness varying from 2½ to 4½ in. in depth on the main spans, with a width of 14 in., and on approach span from 3 to 3½ in. in depth, with a width of 12 in. These planks were laid flat and bolted to each line of stringers by machine bolts spaced 27 in. apart. The planks were given two coats of preservative mixture, applied by brush method. The heads of the bolts were finished flush with the top of the plank and the countersunk hole around the head was filled with Portland cement mortar. The space between the planks was filled with a Portland cement concrete (1:2:4), the top of which was finished smooth at the top of the plank.

On this composite foundation creosoted wood blocks were laid, with a sand joint, and, as stated before, without a cushion. These blocks are 3 in. in depth and cut from 3x8-in. long-leaf yellow pine timber.

Buckle Plates Reinforced

The buckle plates have been reinforced by riveting 3x3x⅜-in. angles to the unsupported fillet of the plate. On the main bridge these angles are riveted to the under side of the plate, and on the approach span, on account of the structural details, they are placed on the upper side of the plate.

The holes in the inverts of the plates are utilized for draining any water that may reach the under side of the wood blocks. This drainage has been provided by forming a hole in the concrete foundation over the holes in the invert of the buckle plate.

To assist the drainage, grooves ¼ in. deep and 1¼ in. wide have been molded in the top of the concrete, which help to lead the water to the drain holes.

The longitudinal movement of the pavement has been checked by the installation of transverse "Z" bars at alternate floor beams, forming longitudinal panels varying from 41 to 80 ft. in length. The tops of these bars are flush with top of the pavement.

Pavement Weight Decreased

In determining the design of the new pavement the department had before it the fact that there would be approximately 780 lbs. per linear foot of bridge added in rails, ties, guards, signal system, etc., for elevated train operation. It was quite important that this added load should be neutralized, if possible. After considerable investigation a design was perfected that really accomplished it.

In this design the weight of timber per linear foot was considerably increased, but this was more than compensated for by a considerable decrease in other items, so that the net result of the new design showed a decrease of from 3,750.2 lbs. per ft. in the old river span to 2,966.9 lbs. per ft. in the new—a difference of 783.3 lbs. per ft. In the land spans the decrease was 782.8 lbs. per linear ft.

It will be observed that the weight per linear foot on the river and land spans has been decreased proportionately. This was necessary on account of the fact that the department did not desire to change in any way the relative equilibrium of these spans.

The entire work of relaying the pavement, strengthening the buckle plate floor and reconstructing the curb is being done by departmental labor, the materials required being purchased by contract or open-market order.

In contracting for the wood blocks—1,600,000 3x3x8-in. blocks, 16-lb. treatment—proposals were requested on three specifications, differing in so far as the kind of oil to be used, namely, coal-gas tar, "Light;" coal-gas tar oil, "Heavy," and water-gas tar oil. The lowest bid per 1,000 blocks for each class was $27.36 for light oil, $25.90 for heavy oil, and $24.84 for water-gas oil. Four bidders submitted proposals on each specification. The contract was awarded on the heavy-oil specification at $25.90 per thousand, or $1.39 per square yard.

To measure the deflections, under traffic, of the buckle plates, a gauge was made for the purpose and set at various points on the under side of the fillets of the buckle plates. The gauge was left in position for a period of from three to five days, and deflections up to 9/16 in. were noted. After the stiffening angles had been installed similar observation were taken, but no deflections were found on these plates.

Williamsburg Bridge

The Williamsburg bridge was opened to vehicular traffic in December, 1903. It has two roadways, each 19 ft. 11 in. in width. The main bridge is 2,793 ft. in length from anchorage to anchorage, and the two approaches have a combined length of 4,515 ft., making a total length of bridge of 7,308 ft., which means an area of 32,480 sq. yds. of pavement to be maintained.

The approaches are paved with Medina (N. Y.) sandstone blocks, on a Portland cement concrete foundation (1:2½:4½). This foundation varies in depth according to the different bases on which it rests. On the earth fill it is 6 in. in thickness, on buckle plates (with buckles up) it varies from 4 to 7 in., and on the corrugated trough plates from 3¼ to 12 in.

Old Pavement Too Soft

This pavement, of which there are 20,065 sq. yds., has worn very rapidly. The Medina block is a very soft stone, and the blocks at and near the curb have shown a reduction in depth of 4 in., due to wear. The specifications for these blocks required a thickness of not less than 4 in. nor more than 5 in., a depth of not less than 6 in. nor more than 6¼ in., and a length of from 7 to 12 in. The pavement was laid with Portland cement grouted joints.

Funds were available for the repavement of two approaches. Granite blocks, 5 in. in depth, laid with asphaltic cement joints, will replace the sandstone blocks.

The main bridge is paved with creo-resinate long-leaf yellow pine blocks, 4 in. in depth, and cut from 4x8-in. planks. These blocks are laid at right angles to the center line of the bridge and rest on 12-in., 20.5-lb. channels, having an average length of 20 ft., laid longitudinally with the bridge, with a space of ½ in. between channels, the web being horizontal and the flanges turned down. These flanges rest directly on 7-in. channels laid transversely on 30-in. centers. The tops of the 12-in. channels were given a coat of hot asphaltic cement, and the blocks were laid on this cement with close joints, filled with an asphaltic and coal-tar compound. In 1909 these channels commenced to show signs of failure, the webs under the heavily increasing traffic deflected badly, and in many cases

this continued deflection caused fracture, necessitating the replacement of many of these channels.

Economy in Shallow Blocks

The plan proposed by the author seemed to offer a minimum of inconvenience to the traveling public, as well as being economical. This plan consisted of laying a timber floor on top of the channels and the use of a shallow wood block.

The design consists of laying long-leaf yellow pine plank, dressed on sides and edges to a uniform size of 2½x9¾ in., on the channel floor, from curb to curb in one length, and bolted to the channels by two ½-in. bolts at every alternate channel. The plank was treated by brush method, and before the blocks were laid the top surface was coated with paving pitch. The roadway was divided by transverse angles into equal sections 20 ft. in length. In these spaces were laid creosoted wood blocks 2¼ in. deep, cut from 2x6-in. plank. The wood blocks are of long-leaf yellow pine, purchased on the same specifications as those used at Queensboro bridge.

There are about 1,500 sq. yds. of this shallow block pavement in place.

This is the first bridge where blocks 2¼ in. in depth have been used. They are standing up well under the traffic. It proved to the author that if the wood underdeck is securely bolted to the supporting structure, the shallow paving block can be safely used. Its use means a saving in original cost of block of about 17 per cent. as compared with cost of a 3-in. block.

Brooklyn Bridge

The Brooklyn bridge has two roadways, each 16 ft. 9 in. wide, and a trolley track is laid on each of them near the inner curb. This arrangement, when considered with the width of the roadway, means the passing of but a single line of vehicles near the outer curb. This concentration of traffic tends to wear out the pavement very rapidly.

The main bridge is 3,455 ft. 6 in. in length and the two approaches 2,560 ft. 6 in. in length, a total length of 6,016 ft.

The pavement of the main bridge consists of 2½x10-in. spruce plank, laid transversely on 3½-in. to 5-in. creosoted yellow pine timber, laid longitudinally. This underflooring is carried on steel cross-beams. The planking on the up grade averages four months' wear, while that on the down grade averages six months, and that on the part near the center, which is nearly level, averages eight months, which means the renewal of planking twice during the year—a very costly item of expense. Several experiments have been made, and it was finally decided that creosoted yellow pine blocks, 2¼ in. in depth, cut from 2x6-in. plank, on an untreated yellow pine underdeck, would meet all requirements. There are now 150 lin. ft. of similar pavement in place on the north roadway of the bridge.

Present Plan Outlined

The plan provided for the replacement of the trolley rail, which is of a tee section, by a groove girder rail. The tee-rail is not suitable for use in a roadway of this type. It affords very poor facility for the turning in and out of vehicular traffic from track area to roadway area; it is expensive to maintain on account of its inadequate supports, and it is laid to a grade of 1¼ in. above the grade of the roadway. The laying of the girder rail will mean the correction of these defects.

The new design of roadway floor will add 100 lbs. per linear foot of bridge for both roadways, two-thirds of which will be carried by outer cables and one-third by inner cables. The present dead load per linear foot of bridge is 8,000 lbs.—4,480 lbs. on inner cables and 3,520 lbs. on outer cables.

The increase in dead load is more than offset by the fact that the present rough spruce planked pavement will be replaced by a smooth wood block pavement.

New Type of Concrete Bridge

A special type of concrete bridge has been devised to meet the requirements of the arid regions of our southwestern states. These bridges extend across the beds of streams which are dry or nearly dry the major part of the year, but are on some occasions extremely high.

Must Meet Conditions

Practically all creeks and smaller rivers in the district where the new bridge is used are dry eleven months out of the year, and in the remaining one month carry an excess of water for not more than a day or two at a time. A stream will suddenly change its character from a mere trickle or a dry bed to a torrent 10 to 20 ft. deep, returning to its original state in 24 hours. Only in extreme cases does the flood period extend over one or two days.

Such a condition makes a high bridge, in which $2,000 to $5,000 has been invested, comparatively useless during the greater part of its life, and, as little money is available for roads and bridges in these regions, economy must be practiced. Moreover, because of the large amount of debris carried by flood water, the floor of an ordinary highway bridge must be above the flood level, which fact necessitates approaches with wing walls and abutments.

Economy has forced engineers to design a bridge of the type here illustrated, which gives service most of the time without too large an expenditure. This is generally known as a "low-water bridge."

The "Low-Water Bridge"

A low-water bridge in its commonest form consists of several short reinforced concrete spans which clear the ordinary dry or low-water flow. These spans are carried on piers, which rest either on footings, if a rock bed is available, or on a concrete slab when the foundation is sand or gravel. In the latter case an apron or cut-off wall extends into the stream bed to protect the slab from scour.

In the bridge illustrated by the accompanying photograph the piers rest on a slab 60 ft. long placed in the bed of the stream.

LOW WATER REINFORCED CONCRETE BRIDGE OVER SANDY CREEK, PONTOTOC COUNTY, OKLAHOMA.

During the high water these bridges are wholly submerged, therefore guard rails or hand rails are omitted to prevent the lodgment of detritus or suspended matter. In many cases the center of a bridge is lower than the ends.

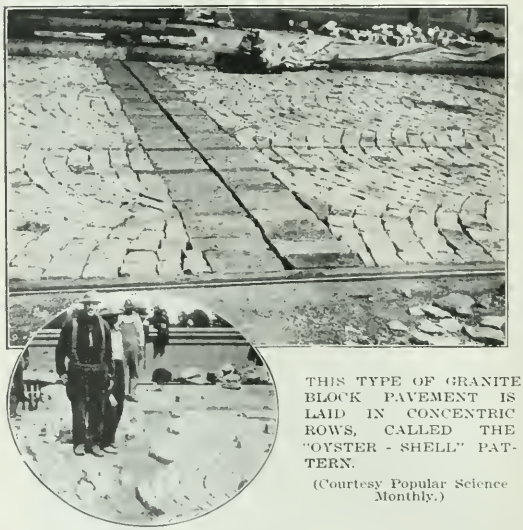
To the dweller in a flat, well-watered country a low-water bridge is rather incomprehensible because of the fact that his native rivers remain in flood for weeks at a time. This is not the case in the Southwest, for during a hard rain few people care to travel, and the average stream becomes a mere creek a few hours later.

ROADS AND PAVEMENTS

Block Paving in New Form

A form of block paving that has for many years been widely used in Europe is now finding quite general favor in certain American cities. The granite blocks as used in this form of street improvement are much smaller than those seen in the ordinary cube block pavement, being cut in the form of 3½-in., or, at most, 4-in., cubes. These blocks, instead of being placed in straight rows, are arranged in a pattern of concentric interlocking circles. Claim is made that such a pavement, properly laid, is practically as smooth as asphalt and easily cleaned.

On account of the small size of block as generally used in this "oyster shell" pattern paving, an excellent foothold for horses is provided.



THIS TYPE OF GRANITE BLOCK PAVEMENT IS LAID IN CONCENTRIC ROWS, CALLED THE "OYSTER - SHELL" PATTERN.

(Courtesy Popular Science Monthly.)

As none of the courses run straight across the street, the load is much more evenly distributed and the shock that comes when two wheels of a heavily loaded wagon strike a course at the same instant is materially lessened.

The Brooklyn-Brighton viaduct, Cleveland, O., was recently paved with small granite blocks laid in the "oyster shell" pattern, on a substantial concrete base, and furnishes a typical example as to methods used in installation. The blocks on this job were laid on a cushion of dry sand and cement, the section laid each day being thoroly wet down at night. A mixture of equal parts of sand and cement brushed into joints between the blocks united the whole into a monolithic mass.

Costs as given on this work were $2.50 per square yard for labor, cushion, blocks and grout.

Care in Details Lowers Roadbuilding Costs

By Leslie H. Morris, Cupertino, Cal.

The first requisite of a good concrete pavement is a sound subgrade, and the basic quality of a sound subgrade is a uniform texture of its components. To secure satisfactory and acceptable results at the lowest cost, this last point must be kept constantly in mind, no effort being spared to reach as near perfection in each step of the work as is possible. Any lack of uniformity will result in shrinkage, which will require rerolling—or, if this is neglected, it will manifest itself as a crack in the finished pavement, and injure the reputation of the builder.

In the destruction of the existing roadway a type of scarifier should be selected with which a uniform depth of disturbance may be maintained. This is best affected by adjusting the teeth to the inequalities of grade by means of levers fulcrumed on a wheel-carried frame. The market offers a range of this type of machine varying from extreme lightness to a combination grader and scarifier representing extreme stability. But irrespective of type, the work should proceed in a manner that will destroy the maximum of large lumps and clods. An orchard disk will be found very useful for completing the work.

Use of Water in Making Fills

In making fills the best results have been attained by limiting layers to one foot in thickness, by a liberal use of water, by spreading going and returning teams over the entire width, and by rolling. For fills of two feet to six feet diking and flooding is employed, seepage to undisturbed ground being thereby secured. For depths greater than six feet, a winter's rainfall is necessary to secure a complete settlement.

A string stretched between nails driven in opposite grade stakes will enable a skillful operator to grade within ¾ in. of the bottom edge of the header boards. Each header zone and the foot outside should then be wet and rolled in order that the stakes to which the header boards are nailed may be properly supported. The header boards act as forms for the concrete, mark the finished surface of the paving, and are guideways for the proper elevation of subgrade. It is therefore important that they be carefully set and maintained to true grade by nailing them to 16-in. stakes set about 7 feet apart.

Making a True Surface

Before using the shaper-templet, the area inclosed by the headers should be as completely pulverized as possible, and reduced to a uniform texture by sprinkling lightly and harrowing until mealiness is effected. This will assist in securing a true surface. In using the shaper-templet it is essential that each end shall be constantly in contact with the header boards, and that its shoe shall conform closely to the required curve of the finished subgrade.

When the subgrade has been properly harrowed and brought to the desired contour, it should be watered suf-

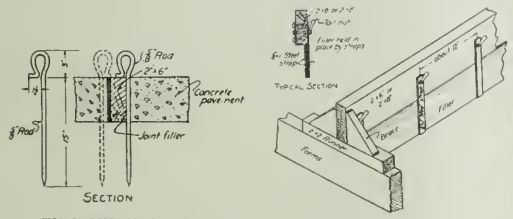
ficiently to insure that the moisture will penetrate to the undisturbed soil. Unless this is attained no bond will be established. Uniformity of sprinkling is necessary, and the best results are secured by a double application. As a preparation for rolling, a light harrowing, as a slight crust is forming, is excellent. Its tendency is to furnish pulverize the subgrade and reduce any non-homogeneous elements or inequalities of moisture. Experience is the best indication of the precise moment to begin harrowing. At least a ten-ton roller should be used as soon as the subgrade has dried sufficiently so that it will not "pick up" or "wave." Twice over will usually produce an unyielding surface, which may be made still harder and sealed by sprinkling for a few days. Once sealed maintenance must he kept up by sprinkling at intervals of a few days, depending on the weather, until the surface is covered with concrete.

Time Work According to Weather Reports

A low subgrade may be traced occasionally to a variation in the coefficient of compression of the soil. This is best remedied by thoroly scarifying to a minimum depth, after which more earth is thrown on and the shaper-templet, adjusted for the estimated shrinkage, dragged over. Rain for a week or ten days is a feature of most California paving jobs. The tendency of the beating and soaking is to make a subgrade still harder. It is excellent policy to roll all sections that are ready when advance information of rain is received from the Weather Bureau.

Installing Premolded Expansion Joints

A simple method of placing premolded sandwich type expansion joints involving the use of specially made steel stakes has been devised by an Iowa contractor. The accompanying drawing shows the form of this stake. In setting a joint by the new method a line is stretched at the desired location and a 2x6-in. header is staked to it This header is held down by a row of pins set so that the lugs bear on the upper edge. The filler is held in place by another set of pins, as indicated in the diagram at the left.



TWO METHODS OF PLACING PREMOLDED JOINTS.

When the concrete work has extended about a foot beyond the joint, the pins holding the header are taken out and the header removed. The pins holding the joint are left until the header space has been filled with concrete.

Another method which does without pins involves the use of a 2x6-in. plank set on runners arranged to ride on the side forms. This bridge is fitted with iron straps placed about 1 ft. apart, each strap being provided with a tail nut. The filler is gripped firmly between the straps when these nuts are drawn up. This arrangement, shown in the diagram at the right, has the advantage of being entirely self-contained and without loose parts.

Creosoted Wood-Stave Pipe Line

Water is now supplied to the Wenatchee reclamation district thru a 63-in. creosoted wood pipe line recently laid. This is one of a very few lines of this type laid, tho the use of creosoted wood here has numerous advantages, chief among which is the fact that the staves are non-swelling, and hence can be clinched tight when the line is put down. Tests showed that no creosote taste was present in the water carried by the treated pipe.

The City of Non-Skid Streets

Cincinnati, a city which possesses many miles of worn-out granite block pavement, in a condition highly discouraging to the use of automobiles, has, according to the *Scientific American*, discovered a way of renovating its thorofares at very slight expense. Indeed, the made-over paving possesses the great advantage of being practically skid-proof, at the same time affording proper footing for horses, even when the ordinary pavement is unsafe.

The only new material required by this process is a small amount of cement and sand. The old granite blocks are taken up and thoroly cleaned of all adhering fillers. The worn-out sand bed is removed and wherever necessary the cement foundation is repaired. A new sand bed is laid, using old and new sand indiscriminately, and the blocks are then relaid with about ½ in. space between them.

The relaid paving next receives a thoro flushing with hose, and while it is still wet a mixture of two parts sand to one of cement, with enough water to make it flow readily, is raked

RE-LAYING BLOCK PAVEMENT IN CINCINNATI STREET.

and swept into all the interstices. Before this filler dries a finishing coat of sand and cement in equal proportion is spread evenly over the entire surface of the pavement. This surfacing coat makes the street as smooth as newly laid asphalt; and the longer it stands, the harder it gets. Four days are allowed for firm setting before the street is opened to traffic.

Experience is that the cement grouting never chips from the granite, but actually becomes better with continued traffic. It affords a non-slippery surface in winter and in wet weather alike. The smoothest tire will hardly skid on it, and, unlike brick and wood block paving, it does not cause horses to slip.

Streets which were resurfaced five years ago are in as good condition to-day as when just completed. As fast as the granite pavements need repairing they are being resurfaced by this method, until Cincinnati is fast becoming the city of non-skid streets.

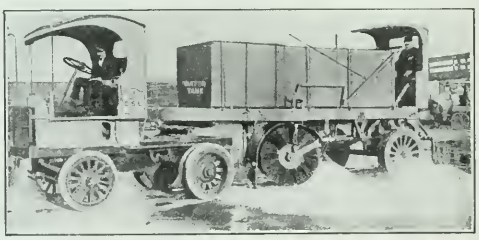
Maintaining Road Shoulders

During 1916 the New York highway department maintained over 6,000 miles of roads. This work was under the direction of Fred W. Sarr, second deputy commissioner, who gives in his report for the year the length of each type of road maintained and the cost of the work per mile. During recent years there has been some question whether it is fair to the different classes of road surfaces to include in the cost of maintaining them the cost of maintaining the shoulder on each side of the surfaced roadway, as is done in the New York figures. It has been claimed that the maintenance of the shoulders is affected by many local conditions, such as slope, rainfall, traffic and width of surfaced roadway, and that the cost of maintaining the shoulders should therefore be kept distinct from the cost of maintaining the roadway. Mr. Sarr takes the contrary view for the following reasons: "In view of the fact that the traffic is not confined to the pavement by curbs and the earth shoulders are a part of the traveled roadway, the cost of the maintenance of the pavement has not been separated from that of the shoulders. This method would seem more consistent for the purposes of comparison, for the reason that the cost of maintenance of the shoulders of those pavements, having a general low cost, is much higher than for maintaining the shoulders of those pavements which have a general high cost."

Gas-Electric Sweeper and Flusher Cleans New York Streets

In New York City the problem of efficient street cleaning has been solved by a specially built combination sweeper and flusher. While the prime mover is a gasoline engine, all of the power is converted to electricity before it is divided up among the different jobs.

Acting as an all-around power plant, the gas engine supplies current to a motor, which furnishes driving power to



HIGH PRESSURE STREET FLUSHER USED BY NEW YORK CITY'S STREET DEPT.

the truck wheels. Another motor turns the broom, another the flushing pump, and still another the atomizing pump. All of the auxiliary motors are controlled by the man in the rear, who gives all his attention to the cleaning operations.

It is claimed that this machine can clean between 100,000 and 125,000 square yards of paving per day and can thoroly cover a strip 15-ft. wide. Moving at a speed of 9½ miles per hour, which is well within its capacity, it could easily take care of 50 miles of street in a 10-hour shift.

The tank of this novel flusher has a capacity of 1,675 gal.

Road Improvements Badly Needed

At a recent convention of the Ohio Good Roads convention especial stress was laid on the necessity of better roads as an aid in helping the farmer mobilize his resources in the cause of humanity. Delegates from the farms did not ask to have the roads improved for them, they promised their full proportion of financial support for their construction. Different conditions are reported from New England, New York and New Jersey. There the congestion of railway traffic makes the highways of great value in delivering manufactured materials from one city to another and the motor truck has become a real necessity in meeting the urgent requirements for transporting the products of the cities.

Both of these cases show that the rational improvement of roads is an essential element of the grave economic problem of the day, to make the valuable products of the farm and shop available to the user at the lowest possible cost. This subject should be studied at once as an economic problem, the same as the provision of railway and waterway transportation, the increase in cultivated acreage and the improvement of manufacturing facilities. Crops that cannot be moved from the farms except at enormous expense are of little value to a nation which needs them now.

National Military Highways

A bill providing for the construction and maintenance of a "belt highway" along the borders and seaboards of the United States was recently introduced in the United States Senate by Chairman Geo. E. Chamberlain, of the committee on naval affairs. According to the plans set forth in Mr. Chamberlain's bill, the highway is to extend the full length of the Atlantic seaboard, thence west skirting the Mexican border and northward along the Pacific coast. While the section paralleling the Canadian border line is not to be built at the same time as the other stretches, it is provided for, and will, according to terms of the measure, be built at a later date, should the bill pass.

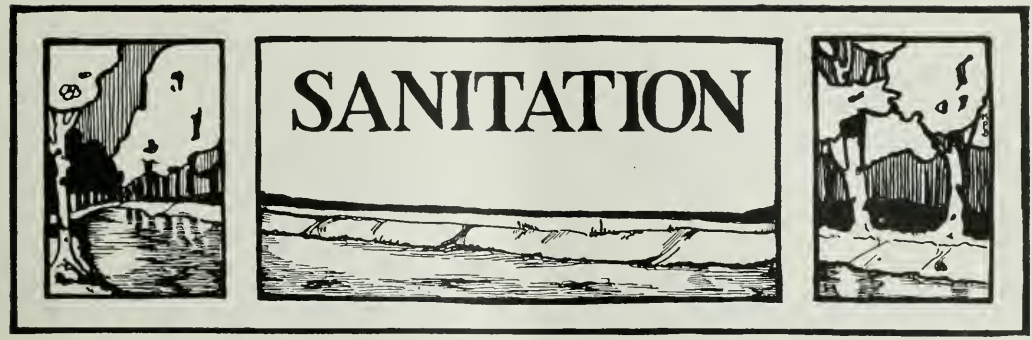
Provision is also made for a supplementary plan of main radial roads intersecting the military marginal highway "at points and of locations and routes calculated to best serve military requirements." These radial highways are to be such as "have heretofore been constructed by the states, or as may hereafter be constructed by them independently or with Federal aid."

Pavement Expansion Cracks Curb

Lack of expansion joints in concrete work has been the cause of a quite general sidewalk and curb trouble in the city of Florence, S. C. At several points the expansion of pavement and walk has pushed the gutter back under the curb; at other places the curb has been pushed back as shown in the accompanying photograph.

Most of the sidewalks in Florence were built in 1907 and remained practically intact for five years. At the end of this period the city streets were paved with bitulithic laid on a 4-in. concrete base. This had neither longitudinal nor transverse expansion joints. When the expanding concrete met with rigid resistance, the cracking described was inevitable.

CURBING RUINED BY PAVEMENT EXPANSION.



Water and Light Methods and Suggestions

By Paul W. Doerr, Assistant Superintendent, Water and Light Department, City of Lincoln, Neb.

The receipts of the city water and lighting departments of the city of Lincoln, Neb., are regularly verified by comparing each entry on the cash book with the duplicate of the receipt issued to the consumer at the time payment was made. These duplicate receipts are filed with the city clerk and auditor, are correctly entered up, and the proper amounts turned over to the city treasurer. The treasurer's receipts must agree with all entries made of the same, and vouchers are kept on file for several "refunds" made to correct "misreadings," "duplicate payments" and "refunds on tenants' deposits." Monthly reports covering the work of both departments are made and filed with the city auditor.

Cash Register Accounting

The cash register (specially built by the National Cash Register Company for the use of these two departments) is kept in constant use. This registers separately the receipts of each department, stamps the consumers' receipts and the duplicate with a consecutive number, and adds all receipts and indicates the total for the day. At the close of business the city auditor calls and takes off the last number of receipt and the total of the collections and charges the department with this amount. At the end of the month the department's figures must agree with these figures kept by the auditor, and so, in turn, must the payments to the city treasurer.

The receipts of the water department total $163,962.09, as against $148,876.56 the year before. The lighting department collected from all sources $20,537.34, compared with $10,885.17 during the prior year. From our schedules it is noted that these departments have turned over to the city treasurer the funds collected several times during each month, sometimes as many as three times during one day. This kept the liability of these departments low, the greatest amount at any one time being $5,558.46, on April 11, 1916.

WATER WORKS ACCOUNT

Cost of water works to August 31, 1915	$1,065,728.45
Additions from Aug. 30, 1915, to Aug. 31, 1916	69,335.60
Total cost to Aug. 31, 1916	$1,135,064.05

THREE-TON ELECTRIC TRAVELING CRANE.

Amount of water pumped during the year, less slippage, 1,304,325,200 gals.

Water furnished to city annually, and for which the department receives no pay:

853 hydrants, at $45 each per year	$ 38,385.00
Water used in all city buildings, public libraries, flushing sewers, and for all other public purposes, 443,502,290 gals., at 15c per thousand gallons, would amount to	66,525.34
	$104,910.34

	Gallons
66 per cent. of total pumpage accounted for	860,822,910
34 per cent. of total pumpage furnished free to city	443,502,290
Total amount of water pumped	1,304,325,200

Using the 1,304,325,200 gals. as a basis and $59,899.34 the total cost of operation, the cost per 1,000 gals. will be .0454, but it must be considered the water department receives only a revenue on 860,822,910 gals., and the 443,502,290 gals. are furnished free to the city in general and paid for indirectly by the water consumers. Taking this into consideration, the cost of distribution is .069 per 1,000 gals.

The per capita consumption of water, using 55,000 population as a basis, is 65 gals. per day. Average daily consumption is 3,573,493 gals.

The following table shows the number of meters in use, the size and kind:

	⅜ in.	⅝ in.	¾ in.	1 in.	1½ in.	2 in.	3 in.	4 in.	6 in.	Elevator Counters
Crown	4	9378	108	91	21	24	15	11	3	..
Hersey	.	498	41	8	..	1	2	1	.	..
Gem	.	....	...	..	..	..	1	1	.	..
Trident	.	5	1	..	..	..	..	..	.	..
Worthington	.	2	...	..	..	..	..	1	.	..
Union	.	....	...	..	..	..	..	..	1	..
Elevator counters.	.	....	...	..	..	..	..	..	.	2
Thompson	.	5	...	..	..	..	..	..	.	..
Davey	.	....	1	..	..	..	..	..	.	..
Nash	.	....	1	..	..	..	..	..	.	..
Total, each size.	4	9888	152	99	21	25	18	14	4	2

Total number of meters of various sizes and makes in use to August 31, 1916, 10,225.

Installation of Service Pipes

Just inside the basement wall of the dwelling, or building, into which the service pipe extends, a stop and waste cock should be conveniently located and arranged so that the water may be drawn back and all the pipes within the dwelling, or building, emptied thru said stop and waste by opening the faucets at the highest points therein and allowing the air to enter said pipes. All of the pipes connected with the service inside the dwelling, or building, should be laid with an inclination toward the point in the cellar where the stop and waste are located, without any sags or pockets, so that the pipes may thoroly empty themselves from water when said waste is opened. But in cases where such sags or traps are unavoidable, an additional stop and waster should be put in.

The service pipes in the dwelling or building should be located in the parts thereof best protected from frost, and should in no case be carried any considerable distance along side walls, but should be carried immediately under the bottom of the basement or cellar to the center or least exposed point therein, previous to being carried upward into the inhabited parts of the dwelling or building. No water supply should be laid in the same trench with lateral sewer. A record of the locations and sizes of all service pipes laid during the year, together with all necessary data, has been kept, so that, in case the boxes are covered up, they can be readily located from accurate measurements recorded.

Charge for Fire Hydrant Service

It is evident to the thoughtful investigator that the cost of

BOTTOM OF SUCTION PIPE ON THREE MILLION CENTRIFUGAL PUMP.

full fire hydrant service or public fire protection, as well as other forms of public water service, should be borne by the taxpayers of the entire community within its radius of ready-to-serve and not alone by the water rate payers; for, otherwise, the non-resident taxpayer and the non-rate payer avoid some charge of their public duty. In other words, why should not a charge be made to the city as a corporation for the hydrants, such charges to be collected from the general taxes and credited to the operations of the water works?

The Public Service Commission of Wisconsin is charging the municipality for whatever water is used, no matter for what purpose; and, in doing so, they give credit for the reduction by a reduction in the private rate of the people, which is a very satisfactory method of procedure.

Hydrant service is no part of the service of furnishing water for domestic purposes, and the latter should not pay for the former.

WATER JUST DROPPING.

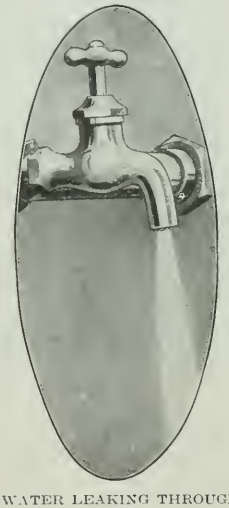
15 gal. per day
105 gal. per week
5,460 gal. per year
Cost per day...$0.003
Cost per week. .01575
Cost per year.. .819

WATER LEAKING THROUGH 1/32 OF AN INCH APERTURE.

264 gal. per day
1,848 gal. per week
96,096 gal. per year
Cost per day.....$0.039
Cost per week.... .27
Cost per year....24.024

WATER LEAKING THROUGH 1/16 OF AN INCH APERTURE.

835 gal. per day
5,845 gal. per week
303,940 gal. per year
Cost per day.....$0.125
Cost per week... .876
Cost per year....45.591



WATER LEAKING THROUGH 3/8 OF AN INCH APERTURE.

39,657 gal. per day
277,599 gal. per week
14,474,805 gal. per year
Cost per day....$ 5.94
Cost per week.. 41.58
Cost per year...2,168.10

If the correct principle was applied water rates would be lower, altho tax rates might be higher, but the taxpayer and the rate payer would be paying for the service received upon a fair and equitable basis.

Meter All Fire Lines

All connections for private fire protection should be metered. The property owner who installs a system for fire protection on his property makes a very substantial profit from the large reduction in his insurance rates, and we do not believe that it is the duty of the city to furnish that protection by supplying the necessary water pressure unless it is done in such a manner as to absolutely protect the city from the possibility of water being drawn thru the pipes for purposes other than fire protection.

Edson Recording Pressure Gages

Edson recording pressure gages with charts are used in the office and station, showing the exact variations in pressure in steam and water, both day and night, giving the time and duration of all changes, also an additional gage showing the water pressure in pounds per square inch and the feet head. The department could not afford to be without the continuous and indisputable information supplied by these instruments. They compel safe, intelligent and efficient operation.

The Uniform Electric Rate

Assuming in all cases that rates for electricity must be based on cost of service plus an equitable fixed charge, which includes all expense incurred solely on account of the customer's installation, which are:

1. First cost of watt-hour meter.
2. Meter reading, billing, bill delivery and bookkeeping.
3. Meter installation, removal, maintenance and testing.
4. Customer's repairs, including household devices.
5. Cost of service connection from pole to building.
6. Maintenance of service connection.
7. Renewing fuses and other general office expense, such as printing, cost of fuses, etc.

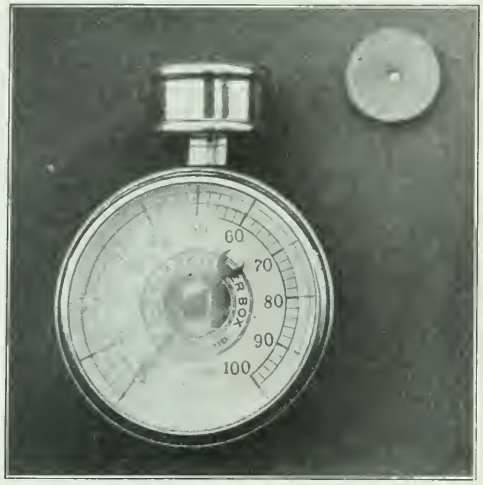
In a good many other cities a guaranteed charge per month for each horse-power or fraction thereof for power apparatus has been made. In Lincoln this has been done away with since the municipal plant has been selling current.

The municipal lighting department is growing rapidly without any special bond issue, and we believe the majority of the people of this city would rather have us be conservative and get a solid foundation instead of being overtaxed with a large bond issue.

A very interesting analysis of elements entering into cost of service is given by Percival Robert Moses, E. E., whom we quote in the following:

Manufacture of Electricity

A difference in electric pressure (voltage) is created by revolving a set of copper wires between magnets, and an electric flow (current) occurs between places when the places are connected together by a conductor, and a lower electric pressure (voltage) exists at the one place than at the other. The quantity of current (amperes) which will flow depends solely on the amount of difference in electric pressure at the two places and the resistance of the conductor to the flow. This resistance corresponds to the friction in water pipes, and, with copper conductors, increases as the length increases and decreases in proportion to the increase of area (diameter) of the conductor. Hence a wire twice as long as another of the same area will have twice the resistance, and one with twice the area, but of equal length, will have one-half the resistance.



A NOVEL LEAK INDICATOR.

Made as Needed

Electricity must, generally speaking, be made as it is needed. The use of a high-tension feeder system makes the location of the main station practically independent of location of consumers.

The size of a connection from the wire network to the customer, known as the service connection, will depend on how much current will have to be supplied at any one time, and, if there is only one customer for the one service connection, the size of his meter will depend on the same condition. If, however, as in an apartment house, there are many customers for one service, the service connection will still depend on the demand of the group as a group, but each customer will have a meter depending upon his individual maximum requirement. A station supplying a residence district will not make its maximum demand on the central station until two hours after the business district makes theirs. Therefore, there is no justification for any difference in rates charged for residence use and in the rates charged for business purposes.

It appears, therefore, that there is no difference in the operating cost of the large and the small consumer, if each pays his fixed charge.

Novel Leak Indicator

For use in detecting leaks in underground pipes an ingenious leak indicator and a very sensitive sonophone have been developed by the water works officials at Mattoon, Ill.

The leak indicator is a simple pocket-size pressure gauge designed to withstand the water hammer to which it is necessarily subjected in service. Connection of the universal type is used, so that the indicator may instantly be attached either to a hydrant, sill cock or bibb.

As used at Mattoon the sonophone is a simple adaptation of a watch-case telephone receiver, a jointed rod leading from the receiver diaphragm to the pipe. Any leak in the vicinity of the test is indicated by the sound as heard in the receiver. Any such sound is transmitted from the leak itself thru the pipe, and then is carried thru the jointed rod to the metal diaphragm of the watch-case receiver. Claim is made that this inexpensive piece of equipment enables the user to detect very small leaks. This extreme sensitiveness is in part due to the fact that the rod is free from mechanical contact with any part of the device except the diaphragm to which it is fastened.

Water Purification in Panama

Residents in the Canal Zone are now supplied with pure, aerated water treated in plants of which any large city might justly be proud. The three plants, located at Miraflores, Mt. Hope and Agua Clara, are all in direct charge of Geo. C. Bunker, physiologist for the Canal Zone.

The Agua Clara Plant

From the Agua Clara purification plant filtered water is supplied to the Gatun district and Toro Point. This purification plant is of concrete construction and includes a mixing chamber, sedimentation basin, rapid sand filters and a clear-water basin. Raw water and alum solution are thoroly mixed in the concrete mixing chamber by means of a series of vertical baffles. In size the chamber itself measures 5 ft. x 30½ ft.

A 350,000-gal. sedimentation basin at the Agua Clara plant measures 70½x71 ft. in plan and is 10½ ft. deep. This is separated into two equal divisions, each of these divisions being further subdivided by a baffle wall. From the basins the settled water enters a receiving box, passing from there to the filters.

Four sand gravity filters make up the rapid sand filtration plant. These measure 17 ft. square each in plan, and are 9 ft. deep, being arranged in two rows of two units each. Each unit has a sand area of 279 sq. ft. and will filter 646,000 gal. of water per hour when operated at capacity.

Each of the four filters is provided with a layer 24 in. in thickness of graded Chagres river sand and 30 in. of Chame Beach sand. An underdrainage system of the Harrisburg type

ONE OF PANAMA'S WATER PURIFICATION PLANTS

is used. Four-inch air pipes are tapped into the manifolds. In washing the filters air is applied for five minutes and the water at the rate of 3,800 gal. per minute. Wash water is carried away by two concrete troughs.

Installation at Mount Hope

In the aeration basin at the Mount Hope plant, which sup-

plies water to Mount Hope, Colon, Cristobal and Margarita Point, five batteries of 17-cone nozzles each discharge the raw water at an angle of 30 degrees. This water takes the form of a thin sheet and breaks up into very fine drops. After aeration the raw water is thoroly mixed with the alum solution in three mixing chambers, all provided with baffles.

Special interest is attached to the sedimentation basins of the Mount Hope plant. Here the alum-treated water flows into three cross-connected basins, the total capacity of which is 2,500,000 gal. Each basin measures 171 ft. in length and one-third that width. Depth at floor valleys is 13 ft. 6 in. and at the summits 12 ft. 3 in. Two pressure walls separate each of the basins into three compartments, connected only by rectangular openings below water level. Between the pressure walls are also light baffle walls.

Each of the six concrete sand filters at this plant has a capacity of 1,226,000 gal. per 24 hours. Sand area per unit is 513 sq. ft. As in the Agua Clara plant, the Harrisburg underdrainage system is used.

Maintenance of Motor-Driven Deep-Well Pumps

By Melvin L. Enger, Assistant Professor of Mechanics and Hydraulics, University of Illinois

There seems to be very little published information concerning the cost of operation of deep-well pumps. The following notes, altho not as complete as might be wished, may therefore be of value.

	—Well Number—				
	1	2	3	4	5
Date drilled	1900	1907	1904	1905	1914
Depth, feet (about)	138	140	142	140	140
Diameter, inches	8	8	8	12	12
Cost of well, casing and screen	$559	$546	$699	$1348	$891
Cost, motor and pump	$375	$813	$788	$758	$810
Capacity, g.p.m., 1914 tests	60	69	81	71	75
Speed, r.p.m.	31	33	28	30	30

The following table gives the cost of labor and material required to keep these wells in operation for a period of sixteen months:

During the period included in the table the wells were in operation as follows: No. 1, 44 per cent.; No. 2, 34 per cent.; No. 3, 70 per cent.; No. 4, 86 per cent.; and No. 5, 89 per cent. of the total time. Taking the average, the wells were in operation 65 per cent. of the total time, or 15.6 hours per day.

The pumps had been in use for periods ranging from one to eleven years, hence the results should represent the average performance of the pumps during their useful life fairly well. The principal cause of trouble is the fine sand getting into the well and into the pump. Rods, couplings, working barrel and packing are worn quite rapidly. The conditions under which the pumps work are decidedly poor, which accounts for the high cost of maintenance.

The total cost of maintenance for the five pumps during the sixteen months was $1,008. This is equivalent to a cost of $151 per year for one pump operating 15.6 hours per day. Put in another way, it is equivalent to a maintenance charge of 82 cents per 1,000 gal. pumped.

	No. 1		No. 2		No. 3		No. 4		No. 5	
	Labor	Mat'l	Labor	Mat'l	Labor	Mat'l	Labor	Mat'l	Labor	Mat'l
October	$11.11	$0.00	$14.15	$1.21	$9.11	$0.00	$15.03	$5.90	$3.43	$1.00
1914—										
November	2.60	0.31	3.10	0.00	7.95	1.25	5.15	0.00	35.87	13.18
1915—										
January	1.46	0.94	5.06	0.00	1.86	0.13	42.77	0.15	10.94	6.24
March	10.96	10.10	2.26	0.00	7.71	1.52	1.96	0.39	11.70	0.37
April	3.83	80.84	4.61	0.00	8.18	0.46	5.97	3.30	3.86	1.16
May	3.40	0.19	3.59	0.00	27.17	0.27	3.97	0.31	4.38	7.52
June	5.92	0.45	7.64	0.33	10.10	0.55	6.49	0.54	7.72	9.15
July	49.19	0.64	2.36	0.00	3.23	0.79	2.57	0.14	4.30	0.35
August	3.38	0.01	4.01	0.00	3.06	0.00	3.02	0.00	14.42	0.01
October	6.11	1.64	2.27	0.36	3.80	0.94	6.74	1.09	18.88	0.79
November	6.75	0.07	0.99	0.20	9.73	1.55	0.66	0.93	4.08	16.30
1916—										
January	5.44	0.07	1.91	0.00	2.44	0.35	1.96	0.15	3.65	0.15
February	4.62	0.14	0.95	0.15	1.96	0.32	2.95	0.58	17.70	12.15
March	2.15	0.00	0.80	0.01	30.69	19.18	1.93	0.00	2.57	18.14
April	9.13	0.91	1.47	0.00	41.59	14.70	8.82	6.32	1.86	0.00
May	16.02	3.95	0.99	0.00	16.15	40.85	3.06	23.12	1.90	1.57
Totals	$172.07	$100.26	$56.51	$2.26	$202.73	$82.86	$113.05	$42.93	$147.26	$88.08

The water supply of the University of Illinois comes from five wells drilled about 140 ft. deep in the glacial drift of this region. The water-bearing stratum is about 15 ft. thick and consists of a sand containing much fine material. The water level in the wells when the pumps are not running is about 95 ft. below the surface, and, when the pumps are running, about 110 ft. below the surface.

The water is pumped from the wells by means of motor-driven Luitwieler deep-well pumps. The working barrels are 5¾ in. in diameter and the stroke is 15 in. The pump on well No. 2 is geared directly to its motor; the other pumps are belt-connected.

The following table gives information concerning the wells and pumps:

World's Largest Locomotive Jib Crane

A 500-ton locomotive jib crane recently built for installation in the Panama canal at Balboa, C. Z., is said to be the largest machine of its kind in the world. This giant crane is capable of raising, lowering or swinging a 56-ton load at its maximum working radius of 87 ft. from its center of rotation. The auxiliary hoist has a radius of 97 ft. and the whip hoist of 102 ft.

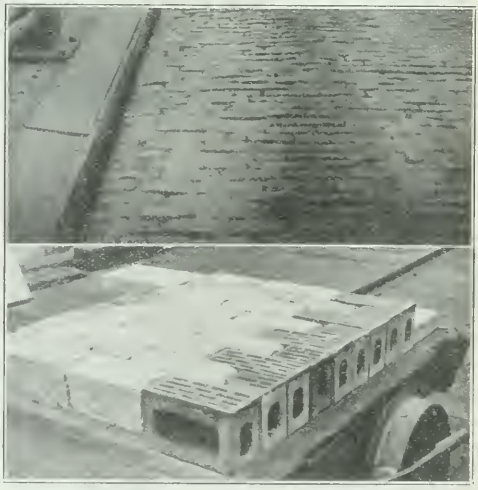
WORKERS IN THE FIELD

Cement-Iron Paving Block

The Editor of MUNICIPAL ENGINEERING:

Sir—Unusual traffic conditions prevailing on the approaches to the Brooklyn Bridge resulted in the adoption of an entirely new form of "armored" concrete paving block. Originally these approaches were paved with 8-in. granite blocks on a 2-in. sand cushion, with tar and gravel joints. Heavy cartage had worn this paving down to a point where replacement was a necessity, ruts having been cut to a depth of 3½ in. at some points.

Particularly heavy wear came on the blocks adjacent to the curbing, this resulting from a general custom of running wagon wheels against the curb, so that the friction of wheels



VIEW SHOWING WEAR OF BLOCKS ON BROOKLYN BRIDGE APPROACH. METHOD OF LAYING THE CEMENT IRON BLOCKS. THESE BLOCKS GO NEXT TO CURB.

against curb acted as a brake to prevent a too rapid downgrade travel. This wearing of the blocks was also quite irregular, producing a series of ridges and depressions which interfered with the speed of the movement of the vehicles, as well as causing severe jolting of their springs. These blocks required frequent repair, and where traffic is so concentrated these repairs have been of great annoyance to the traveling public.

Extra Cost Justified

While the cast iron block cost more than the ordinary form, the additional cost is more than justified, as these blocks are the only sort that would stand up against the wear. The iron castings used are made in the form of a hollow box or "crate," two sizes being used to permit of staggering joints. Dimensions are 5 in. deep by 4½ in. wide, lengths being 4 in. and 8 in., in the two sizes mentioned. Top faces are 1 in. thick; ends and bases are ⅝ in. square metal. Recesses are cast in the top faces to prevent too smooth a surface. The hollow space is filled with Portland cement concrete, which is thoroly set before the block is placed in position in the pavement. The 4-in. blocks average 8 lbs. in weight, and, when filled with concrete, 12¾ lbs. The 8-in. blocks average 13¾ lbs. in weight and 24 lbs. when filled with concrete. These blocks are laid in conjunction with the granite blocks, with which they bond with a lap joint of 4 in. The use of these cast iron blocks at the curb of a roadway 16 ft. in width will increase the cost of the entire paved surface about 10 per cent. over price of granite block pavement.

Granite blocks and the iron-concrete blocks are both laid in a Portland cement with a 1-in. sand cushion, an additional layer of concrete having been laid in the old foundation, so that the new blocks come up to the old grade.

EDWARD A. BYRNE, Acting Chief Engineer.

Municipal Motor Shop

To the Editor of MUNICIPAL ENGINEERING:

Sir—Thru the establishment of a municipal motor shop and the application of spare time on the part of firemen at the engine house with which the shop is connected, the board of police and fire commissioners at Grand Rapids, Mich., have made remarkable strides in the motorization of the fire department. The idea, which was inaugurated about four years ago, stands for a saving of a great deal of money to the city and has been responsible for the addition of eleven pieces of apparatus to the city's complement of thirty-six, nine of which were built complete and two converted from horse-drawn equipment. Two more are now in the process of construction.

The practicability of the plan was discussed for more than a year before any action was taken. Then it was decided that $1,500 could be spent as a trial for lathes, tools and essential parts. The outlay was nominal, and it was figured not to represent an investment, but more of a speculation. Frank G. Hill, master mechanic of the department, was given the supervision. He immediately saw an opportunity for doubling the efficiency of the plan—not only gaining the ends the commissioners had outlined, but working some good in an educational and monetary way for the workmen. These he selected from the corps in the engine house, most of whom were without experience. An agreement was made which permitted the men to work all spare time, outside of time spent in answering alarms, in conducting the work of the shop. For this effort they were allowed 40 cents a day in remuneration for eight hours' work.

The first attempt made was on a combination hose and

squad wagon. The chassis was made by a Grand Rapids firm and a heavy motor was secured outside. Every other part was purchased locally, many of them being turned out in the blacksmith shop connected. The machine required six months in the building, and when completed, with expenditures for labor, it represented a total cost of $2,700. Specifications of the same piece submitted to a motor manufacturing concern called for a cost of $4,000. The saving of $1,300 was chronicled. On test the car made some excellent records and it has done daily service since. It proved the experiment, and the shop became an institution. Orders were immediately placed for two more machines of a similar type, and these were finished within the next year.

All of the work of assembling the machines is done at the shop. And besides the saving to the city and the acquiring of apparatus that would otherwise be considered too expensive for purchase, the shop has had a beneficial effect on the men. During the four years at least ten of the workmen, having become skilled on machining, went out to accept positions of excellent standing. All of the men were grateful for the opportunity to add to their monthly allowance, and the work gave them a chance to evade the lethargy that so frequently characterizes the members of a department. More than anything else, the shop has abolished idle gossip and it has been the means of destroying an inclination to factionalism, which threatened at one time to be disastrous.

Besides the work of manufacture, the shop is used for all the motor apparatus in the department as a repair point. If a machine is damaged and needs repair it is sent immediately to the foreman. All work on the new apparatus is then dropped for the repairs. Recently a hose wagon turned a corner, swerved and struck a tree. The front axle was bent, one wheel dished, the radiator smashed, the fenders torn off, and it sustained many other injuries. It was completely out of commission when towed into the shop at 10 o'clock Monday morning. Tuesday night at 6 o'clock it was turned out, in the best of condition. Aside from the rapidity of the work, the total cost of repairs, including the purchase of parts and labor, was only $39. Had the job been done in a private garage, the cost of labor alone would have been at least that much and the car would undoubtedly have been out of commission for a week.

The shop, considering the original investment and the results that have been secured, is pre-eminently a success. And the idea is one that could be adopted in any small municipality where the work of securing appropriations for purchasing apparatus is difficult. It will be maintained in Grand Rapids indefinitely, and at least two pieces of apparatus will be built or converted from horse-drawn equipment every year until a point of saturation is reached. It will then be continued as an exclusive repair shop.

C. W. Shafer,
Grand Rapids, Mich.

Economical Handling of Heavy Centers

To the Editor of Municipal Engineering:

Sir—In connection with building the concrete arch viaduct across the Susquehanna river for the Cumberland Valley Railroad Company, one of the large items of expense was moving the centers. Owing to the great length of the bridge it was impossible to finish it in one season, and it was built in two halves, one half being built last year and the second half this year. As there were forty-seven arches in the bridge, this made ninety-four moves to be made. The centers were made of four steel trusses, with 4x6-in. yellow pine cut to curvature and bolted to trusses. Lagging consisted of two layers of 3x6-in., with joints broken, and covered over with No. 24-gauge black sheet iron. There were ten sets of centers built of steel and one set of timber. Each center weighed about 18 tons, complete, 74 ft. 6 in. and 77-ft. span. The centers were moved on four trucks built from the running gear or wheel bases of four Western dump cars and 60-lb. steel rails for frames, hung on U bolts from axles. In building the service trestle the height of these trucks was taken into consideration and trestle was built to an elevation below spring line, plus height of trucks, so that when centers were moved the bottom of cord of centers was level with top of trucks. This bottom cord of centers consisted of a 12x12-in. yellow pine, bolted to the

VIEWS OF CONCRETE ARCH VIADUCT ACROSS THE SUSQUEHANNA RIVER. 1—TRUCK RIGS FOR MOVING CENTERS; 2—CENTER READY FOR MOVING; 3—FINISHED ARCHES.

trusses. There were also 12x12-in. yellow pine timbers used to hold the two trucks in position to receive centers. Top of these timbers being level with bottom cord of centers, 2-in. iron pipe rollers were used to roll centers from under arches to trucks. The ten sets of centers were moved nine times and the one set of timber centers was moved three times. The average time required to move a set of centers was six hours, the work being done by the following force: One foreman, six riggers, engineer and fireman on McMyler crane. Each center displaced about 250 cu. yds. of concrete and cost about 7 cents per cubic yard of concrete. Prints show front and rear view of trucks with center in transit. Also finished half of

bridge in east channel of Susquehanna river. The bridge was built by the Robt. Grace Contracting Company, of Pittsburg, Pa., for the Cumberland Valley Railroad. Crosby Tappan, engineer of construction; F. B. Kennon, superintendent in charge for the contractor.

F. B. KENNON,
Atlantic City, N. J.

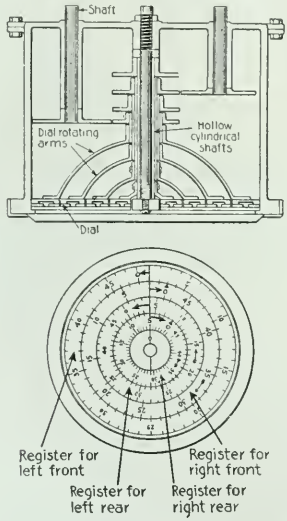
Measuring Loads on Truck Axles

Editor MUNICIPAL ENGINEERING:

Sir—In the operation of motor trucks it has been noted that most of the overloading trouble comes from having too much of the load on one of the springs while the others are perhaps underloaded. In other words, it is easy to determine the entire load on a truck but rather difficult to be sure that the load is distributed in just the proper manner.

Taking into consideration the fact that with every increase in load there is a flattening of each spring over the front and rear axles, it is apparent that the load might be, in a sense, measured by the distance between the axle and the apex of the spring. Each ⅛ in. depression might, for instance, indicate a load increase of 150 pounds. Thus a measurement system of gauging loads would be possible, but hardly practical.

Such a system forms the basis of a newly perfected dial indicator which registers for the driver the exact load on each spring of the truck. On each of the four axles is mounted a



INSTRUMENT FOR MEASURING LOADS ON MOTOR TRUCKS.

vertical rack. Pinions mounted on the side angle irons of the chassis mesh with each one of these racks. With this arrangement any variation of load over any part of the truck causes the pinions to turn by an amount which corresponds with the proportion of the added load that is put on each spring.

The motion from the four pinions is carried by bevel gears and flexible shafts along the chassis to the registering dial which is set in plain view of the driver. The mechanism of this appliance is shown in the accompanying sketch.

While the four weights to be indicated might be shown by four pointers, a movable multiple dial was chosen instead as being more easily read. In this device the dial face is divided into four concentric zones, each moving independently and each indicating the weight over a single spring. All the zones turn in the same plane, but adjacent ones move in opposite directions. Cleverly arranged concentric sleeve bearings allow each one of the zone dials to move freely, each being turned by gears operated thru the flexible shafts that lead to the four pinions.

During the operation of loading the driver has only to watch the dial, instructing the loaders to make whatever shifts are necessary to "line up" the four desired figures. If a total load of 6,000 pounds was to be put on it would be necessary to have in line the four "15's", each of which indicates a load of 1,500 pounds on its springs.

Variations of this idea have also been suggested, one being a piston and cylinder arrangement to operate the dials by hydraulic pressure, and another a system of steel tapes with spring take-ups to turn the indicator. Both of these are more complicated than the device described.

CHARLES H. SEAVER,
Chicago.

A Road Patching Machine

To the Editor of MUNICIPAL ENGINEERING:

Sir—The Los Angeles county road department has adopted the use of a small hand oiler, which is part of the equipment of its trucks as used in the maintenance of paved ways. The hand oiler is made of a sheet iron boiler about 2½ ft. in diameter and 3½ ft. long. It has a cast iron pot hanging in the center of the boiler, capable of holding 20 gal. of oil. A firebox surrounds the pot, which is used sometimes to keep the oil at a certain temperature. The boiler is supported between two iron wheels, and is so balanced that the center of gravity is below the axles, thereby always keeping the pot in an upright position. There is a handle on one side of the boiler, which is used to move the machine from one place to another. On the opposite side, and on top of the boiler, the hand crank for the oil pump is located. The oil pump is the most important part of the little heater, and is fastened to the bottom of the oil pot. The pump is a rotary pump and is driven by a sprocket and chain, which runs to the sprocket on the hand crank located on the top of the boiler.

Heat Applied Between Buckets

This pump is capable of a pressure of from 6 to 10 lbs. The pump is connected with a 20-ft. metallic ¾-in. hose, with a 3½-ft. piece of ¾-in. pipe at the discharge end. The pipe is plugged up with a plug having a slot cut in it so that the oil discharges in a spray. The pipe also has a throttle for turning on or shutting off the oil. The oil that is used in the heater is hauled to the various warehouses when hot and is put into 4-gal. pressed steel buckets. The oil cools very quickly and is cold when it is loaded on the maintenance trucks to be taken to the job. When the oil arrives at its destination the buckets are placed in two long rows on the ground, one upon the other, so that a fire may be built between the buckets and the oil heated to the necessary temperature.

Oil Heated by Distillate

Up to about two months ago wood was used to heat the oil, but at the present time the oil is heated by distillate and water burner invented by one of our foremen of paved ways gangs. The burner occupies very little room and oil is easily heated in 15 minutes to 500 degrees Fahr., during rain or shine. The burner is especially efficient in winter, as it does away with using wet wood for a fire.

With this new heater about eighty buckets of oil may be heated at one time. When the oil is heated to between 400 and 500 degrees Fahr., about 15 to 20 gal. are poured into the hand oiler. One man pushes the oiler to the spot to be repaired, another works the pump and a third man does the spraying of the oil.

On street oiling as much as 125 gal. per hour may be ap-

plied. The best results may be obtained from this hand oiler by heating the oil to about 500 degrees. By heating the oil to the above temperature it is not necessary to maintain a fire in the hand oiler.

This hand-oiling machine, after castings are made, is assembled at our mechanical shop.

F. H. Joyner, Road Commissioner,
Los Angeles, Cal.

Speedy Street Sprinkling

Horse-drawn street sprinklers have been entirely done away with in Worcester, Mass., and a number of other cities in the vicinity, all sprinkling and flushing now being done for these municipalities by means of specially equipped trolley-car sprinklers.

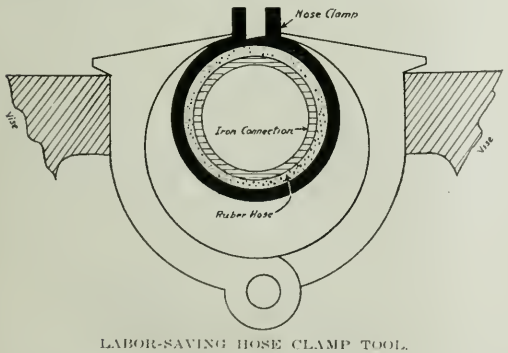
As operated by these cities the sprinkler, which is here illustrated, consists mainly of a suitably designed car fitted with tank of 2,900 gallons capacity, these tanks receiving their supply from specially constructed hydrants between the rails. Pressure for flushing is obtained by a centrifugal pump having a capacity of from 500 to 600 gallons per minute, this pump being operated at high speed by a large electric motor.

Nozzles in the electric flusher and sprinkler are so arranged that each nozzle picks up the refuse left by the nozzle before, the last nozzle beting attached to the swinging arm in such a manner that it carries the accumulation to the gutter. It is claimed that one car will cover from 10 to 12 miles of street in an 8-hour night, working from 10:00 p. m. to 6:00 a. m., when the street is clear from regular traffic. The amount of water used by this method of flushing is about 60 per cent. of that which would be used with wagon sprinklers to cover the same territory.

Tool for Applying Hose Clamps

To the Editor of Municipal Engineering:

Sir—The simple device of which I am attaching a cross-section drawing is one that has been worked out to speed up the task of putting clamps on rubber hose. While the application of a single clamp does not require much time or effort, the shop where this device was worked out found that a great deal of time can be saved where hose splicing is a matter of daily routine. This is especially true if clamps happen to be an extra tight fit or the bolts are a little short.



LABOR-SAVING HOSE CLAMP TOOL.

As shown in the illustration, the device is a "U"-shaped clamp hinged at the bottom and large enough to accommodate hose from 1 to 4 in. in diameter. It may be forged in any shop with but little trouble. In applying a clamp to the hose to hold a connection, the pipe or connection is inserted in the hose and the clamp put in place. The device is then applied so that its jaws will grip the ends of the clamps and the whole is placed in a machinist's vise. By gradually closing the vise the ends of the clamp are brought together so that it may be fastened. In this way a connection for a hose may be made very easily and quickly.

L. Schoolcraft,
1907 Montrose Blvd., Chicago, Ill.

Locomotive Cranes on Sewer Job

To the Editor of Municipal Engineering:

Sir—Locomotive cranes are now extensively used for municipal sewer construction, as indicated by the accompanying illustration. The photograph shows the orange peel bucket, which is utilized to advantage for hard earth, large broken stone and the like.

It may be stated that both the clam shell and orange peel type are equipped with cast steel shoes, or digging points. It

FIG. 2 LOCOMOTIVE CRANE WITH ORANGE PEEL BUCKET IN SEWER EXCAVATION.

is of interest to note that a cubic yard of dry sand weighs 2,700 lbs. and wet sand 3,400 lbs., while loose earth weighs 2,400 lbs. to the cubic yard and wet clay weighs about 3,000 lbs. to the cubic yard.

It may be stated that all of these locomotive cranes are of the revolving type, operated by steam. The lower traveling base or car body is formed of a heavy casting and structural steel, mounted on four wheels or on a pair of standard four-wheeled trucks. On the top is carried the large rotating gear and the turned roller path, upon which the upper base rotates.

The upper and lower bases are securely tied together by a hollow steel center pin, thru which is carried the vertical propelling shaft. The upper or rotating base carries all the machinery, boiler and boom, and is made of a single heavy casting. This construction is in every way superior to a built-up structure, as there is absolutely no possibility of the various parts working loose and throwing the shafting and other parts out of line.

It is claimed that all motions, except raising and lowering boom, are controlled by friction clutches. These are of the expanding steel spring type, and require practically no attention beyond keeping well oiled.

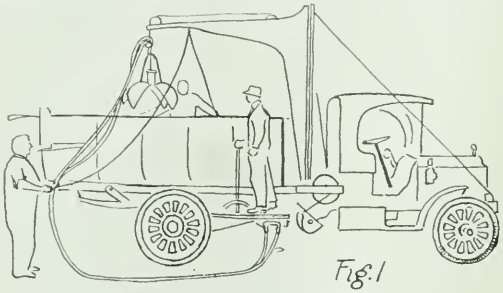
It will be noted that the engines are double and are reversible, with link motion. The cylinders and crosshead guides are cast and bored in one piece, to insure absolute alignment. The boiler is vertical, straight-flue type, and is heavily jacketed with asbestos and galvanized steel. The coal bunker and water tank are of steel, and have a capacity sufficient for a half day of steady running.

Frank C. Perkins.

NEWS OF THE NEW THINGS

By Charles H. Seaver.

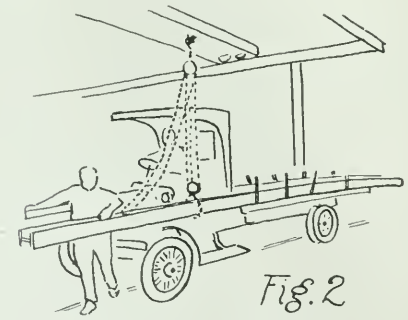
Among the ingenious labor-saving devices that have come to the aid of municipal departments affected by labor shortage is an orange-peel bucket dredge designed for cleaning out catch basins, the apparatus being self-contained and mounted on a dump-body motor truck. With this new dredge the difficult and extremely disagreeable work of cleaning catch basins by hand may soon be a thing of the past. In New



MOTOR TRUCK DREDGE FOR CLEANING CATCH-BASINS.

York, where one of the trucks is now in operation, it is doing the work of four-one-horse carts, while the three men replace nine men, and have a much easier time of it in the bargain.

In the main, the special equipment used consists (as shown in Fig. 1) of a steel arm, in the shape of an inverted "L", this being provided with a hoist operated from the truck engine. All the operations except swinging the arm into position over the manhole, are controlled by the driver, who, with a simple arrangement of levers, lowers the bucket into the catch-basin, closes the clamshell over its load, raises the loaded bucket and dumps the sediment into the truck.



HAND CRANE FOR LOADING TRUCK.

Loads Truck Without Traffic Hindrance

By means of a simple hoist rig (Fig. 2), long steel beams can be loaded on a motor truck without interfering with pedestrians in the slightest degree and without the almost complete stoppage of vehicular traffic that results when a long-wheel-base truck backs up to the curb to take its load. The truck shown is especially built for beams of extra length.

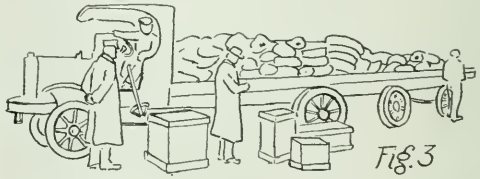
With the truck pulled close to the curb at the loading point, the beam to be put on is raised by a traveling crane and the crane carriage pulled out to a point well over the truck. The tracks of the crane are set high enough so that all loads can be raised to a height of at least 10 ft. above the sidewalk. This arrangement allows beams to be carried clear of the cab and put on the side of the truck farthest from the curb.

No power is used with this device, both the hoist and travel of the crane being controlled by hand. With practically the same equipment, electric motors can be added when loading is speeded to a point where the time element is of sufficient importance.

An Eight-Wheeled Truck

There is extremely little chance that the eight-wheeled truck (shown in Fig. 3) will fail to secure sufficient traction, even tho the roads may be too slippery or muddy for any other type of truck. This giant ten-tonner drives and steers from all eight of its wheels. In spite of the extra long body, the steering feature gives an unusually short turning radius that aids greatly in crowded or narrow streets.

Each of the two sets of four wheels that carry this new truck is mounted on a vertical spindle, similar to that used for the front wheels of the ordinary automobile or motor



EIGHT-WHEELED TEN-TON TRUCK.

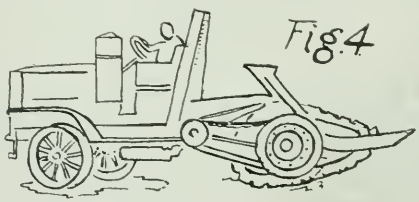
truck. Power is carried to the eight wheels thru a long shaft provided with four worms, one of which turns each pair of wheels, each axle being provided with differential gears. This shaft is turned by a short chain belt working from a jointed extension to the motor shaft. To give further flexibility each axle is divided into three parts, all connected thru universal joints. By this arrangement the inequalities of the road are compensated for, and there is no chance of binding, even tho considerable inequalities are passed over.

Mud Doesn't Bother This Truck

It may safely be said that there is nowhere a road muddy enough or sufficiently sandy to stall the three-wheeled caterpillar truck shown in Fig. 4. This machine has the characteristic caterpillar "pull," but is so built as to retain a considerable amount of speed. Over good roads it will attain a speed as high as fifteen miles per hour.

While the new tractor is primarily built for "rough going," it will run on smooth, hard-surfaced roads, with no damage to the roadway, as the front wheels are equipped with pneumatic tires. These tires are mounted on wide steel wheels. This combination provides perfect resiliency for the higher speeds over good roads, and leaves in reserve a broad, flat steel rim for soft roads.

As an extra precaution against mired trailers, the cater-

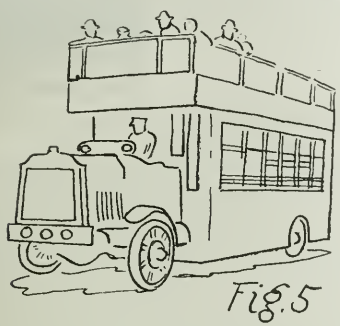


THREE-WHEELED CATERPILLAR TRUCK

pillar is equipped with a powerful winch, which can be driven independently of the caterpillar drive wheel. A tow rope and a strong pull with this device will drag a loaded trailer out of almost any difficulty imaginable.

Chicago's Motor Busses

Chicago's traffic problem, as far as it concerns the North and South Sides of the city, has excellent prospects of relief in the motor bus system which is now in partial operation. At present the busses run to the North Side only, and do not



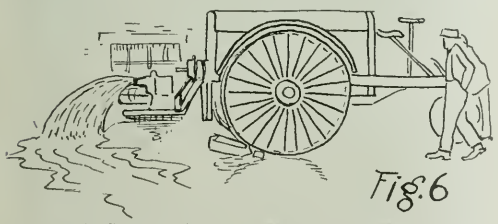
ONE OF CHICAGO'S MOTOR BUSSES.

maintain frequent enough schedules to make any marked decrease in traffic on the street cars during the morning and evening rush hours.

As shown in the accompanying illustration (Fig. 5), these big busses are of the double-decked type, carrying about twenty-five passengers on the upper deck and about twenty on the inside.

Tractor Runs Pump

A new use for a tractor was found a short time ago when one was called into service at Norfolk, Neb., to pump out flooded basements and cellars after an unusually heavy rain.



TRACTOR USED TO PUMP OUT BASEMENTS.

The tractor was pressed into pumping duty to get rid of the extra water after all other means had been abandoned. As illustrated (Fig. 6), the pump was set up at the basement window, and, with the tractor engine belted on, it made short work of its pumping tasks.

Build Track on Pipe

The Editor of MUNICIPAL ENGINEERING:

Sir—To aid in the removal of muck from the four tunnels carrying the Otay-San Diego pipe line, a unique railroad was built, the rails being laid directly on top of the pipe. This railroad was of material assistance in making necessary repairs, as the cleaning process, without some such transportation system, would have been slow and expensive.

The four tunnels carrying the pipe line have for the past eight years stood just as they were originally built, no cleaning or repair work having been done in that period. As a result the tunnel ends were clogged with debris, the drainage was seriously impaired, a good part of the pipe being partly covered with the water that seeped thru small leaks. The timber work was also badly rotted and broken away in many places. Water, mud and rotted wood combined in a slime that was rapidly ruining the pipe.

Prompt Action Necessary

Corrosion and pressure finally caused a bad break, which necessitated very prompt action. As a result, it was decided that the work of cleaning the tunnels and rebanding the pipe

TRACK BUILT ON PIPE LINE.

should be pushed forward with all possible speed. At first only a dozen men could be employed in the choked-up tunnel. As the work went on, more room was available and the "pipe line track" was installed to hurry along the job. A small dump car was used to carry out the muck. Power was supplied thru a cable, by a small hoisting engine, at the tunnel mouth.

C. A. FRANCIS,
Operating Department, San Diego, Cal.

State Highway Department Assistance

One of the most energetic road boards in the country is the road and bridge committee of the Milwaukee County Board in Wisconsin. During 1916 it carried on road and bridge improvements costing nearly $600,000. It maintains a large engineering staff and administrative offices and is in far less need of assistance from a state highway department than are the boards of most counties. Yet in its report for the last year it gives one of the best concise arguments yet made for a strong state highway department. The report points out that a state department is of much help in connecting the roads of the different counties into a united highway system, particularly in designating roads in a county which may not be important to that county, but are of importance to adjacent counties. The state department can also make surveys and maps better than the counties, particularly those which do not have enough such work to keep a permanent engineering staff. The state department is often able to obtain better freight rates than the counties can when acting independently, it can buy materials in large quantities and can test them when delivered, at lower prices than the counties can obtain, and it can bring to strictly local problems the knowledge and judgment acquired by supervising the road work of the whole state rather than a single county.

MISCELLANEOUS

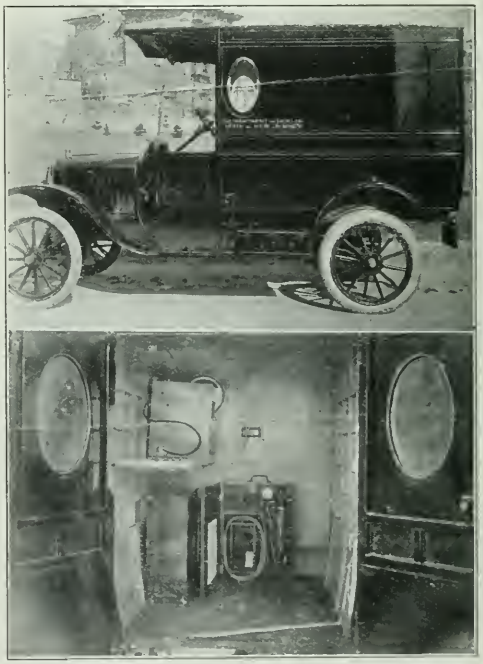
Traveling Field Laboratory

In New Jersey the supervision of the public water supplies, the majority of the sewage disposal systems, the pasteurization of milk and its products are intrusted to the State Department of Health.

The supervision includes, among other things, testing the efficiency of water filtration and treatment plants, sewage disposal plants and the various stages of the pasteurizing process by chemical and bacteriological examinations. To accomplish this work the department maintains a force of trained men who work from Trenton as a base, perform the necessary preliminary chemical or bacteriological work and return to the State Laboratory at Trenton in most every instance at the end of each working day, where such samples as may have been collected are turned over to the laboratory to be completed. It has been found that this system is troublesome, time-consuming and is not conducive to the best results. It frequently becomes necessary to make a week's test of the operation of a water filtration or sewage disposal plant, which has always been found to be attended with many difficulties. It has been shown on several occasions that it would be much better if the department had some means by which it could reach towns threatened by an unsafe water or milk supply more quickly than by relying on trains, which, in some sections of the state, are exceedingly irregular. The department, therefore, recently equipped an automobile with a laboratory and with the necessary chlorine disinfecting apparatus. The automobile is ready for service at any time, and should a water treatment plant become disabled and the quality of the water supplied to the public rendered unsatisfactory and unsafe, the plant can be reached within a comparatively short time and the chlorine gas apparatus installed and operated. The auto has a special body, which is of the same type as the body of a delivery wagon. It has wooden doors at the front, at the rear of the driver's seat, and at the back of the car, which are fitted with suitable locks. The interior of one side of the car is fitted with a laboratory bench and the necessary equipment for laboratory work. Two 37-deg. C. incubators were installed, in which cultures of bacteria can be grown. These incubators are made so that they may be either taken from the car and used on a 110-volt electric circuit, or they may be left in the car and run from a storage battery at 12 volts.

Experience has demonstrated that all places where milk is commercially pasteurized must be subjected to official control, which immediately presents a problem as to how this can best be accomplished. For nearly two years the department has endeavored to check up the various pasteurizing outfits by taking samples, for bacteriological examination, of milk in its raw state and at different stages in the pasteurizing process.

On examining the milk from creameries located in immediate proximity to the State Laboratory, samples after collection are brought to the laboratory to be plated, incubated and bacteria subsequently counted. In collecting samples from pasteurizing plants located some distance from the laboratory it is found impossible to deliver them there until long after closing hours. For this reason the necessary agar plates are made while at the creamery, the plates being brought back later in the day and placed in the incubator, where, after forty-eight hours' growth, they are counted by a member of the laboratory staff. This procedure is found quite satisfactory in all cases except in the extreme upper end of the state. Here the time spent in traveling to the various creameries, as well as the expenses incident thereto, makes the collection and transportation of samples under the plan outlined above impracticable.



AUTOMOBILE LABORATORY IN USE BY NEW JERSEY HEALTH DEPT. BELOW, INTERIOR OF CAR, SHOWING CHLORINE APPARATUS.

Generally speaking, the shorter the time between the collection and examination of milk samples, the more accurate will be the results. With the assistance of the department's new motor laboratory, which can be stationed at some central

point in the remote sections of the state, samples can be collected, plated and brought to the auto laboratory for incubation and counting. Besides effecting a great saving of time and expense, the general efficiency of the work will be materially enhanced.

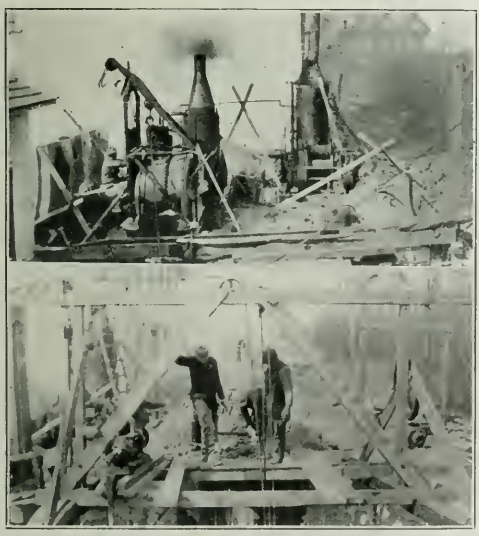
While this traveling laboratory was designed and largely planned by the chief engineer of the department, and will ordinarily be assigned to the work of the Bureau of Engineering, it is to be of service to the whole department, and may on occasions be also used for the control of epidemics of communicable diseases. One of the first uses to which the equipment will be put will be that of examining the milk and water supplies at the concentration camps of soldiers in the state of New Jersey.

Unique Gallows Frame and Hoist

By A. B. DePuy, Jr., Resident Engineer, Remington & Vosbury, Collingswood, N. J.

In connection with the construction of a sewerage system at Bay Head, N. J., it was necessary to sink a shaft 20 ft. in diameter and approximately 20 ft. deep, constructed of reinforced concrete with 16-in. walls. The shaft was built in two sections and each section sunk into place by excavating the interior, which was composed entirely of running sand.

In order to do this in a fast and convenient way it was necessary to erect a hoist over the shaft, as shown in the



CONCRETE MIXER USED AS HOIST ON BAY HEAD SEWER JOB. LOWER VIEW SHOWS FRAMEWORK ON SHAFT.

photograph. The timbers forming the cat head and braces are 2-in. by 8-in. and the posts and bottom stringers are 4-in. by 8-in., notched over two 8-in. by 10-in. timbers laid across the top of the shaft, with end resting on the walls. The whole structure was bolted together so that it could be taken down and reassembled with ease. Two shives were fastened to the top cat head, over which ran the lead, which ran thru a snatch block that hoisted the buckets. The snatch block and hook were balanced by a small counterweight which ran on two small blocks fastened to the cat head. Two buckets, made by sawing a pickle barrel in halves, and reinforcing each with wire rope, were used to haul the excavated material out of the shaft.

The lead from the gallows frame was fastened to the drum of a concrete mixer convenient to the work. This drum on the mixer is used to haul up the bucket by means of a cable run over pulleys on an overhead frame. The cable was detached from the drum and the lead from the gallows frame substituted in its place by running it thru a block fastened to the overhead frame on the mixer. The whole arrangement worked very satisfactorily, and both sections of the shaft were sunk in place without any difficulty whatever.

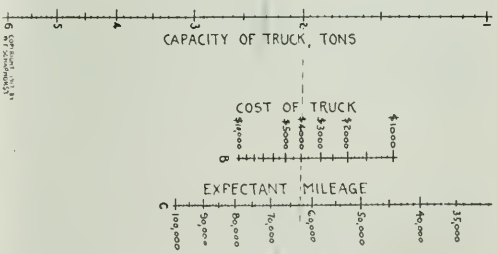
The water was pumped out of the shaft with a pulsometer pump operated by the boiler on the mixer and an auxiliary boiler on an old hoisting engine. The work was done under the direction of E. H. Gardner, superintendent for the Whiting-Turner Construction Company, of Baltimore, Md., contractors for the work.

How Many Miles From a Truck?

Mr. W. F. Schaphorst, M. E., Woolworth Building, New York City, puts it this way: "How many miles can you get from any truck?"

"Nobody can tell off-hand, beforehand or by sleight-of-hand, how far a new truck is destined to travel before consignment to the junk pile or junk dealer. At the end of 100 miles it may be completely ruined thru an accident. At the end of 5,000 miles it may be prematurely worn out thru recklessly poor care. Or, it may run 100,000 miles because of very good care, and still be good for more.

"So much depends upon care, therefore, that a strict mathematical determination of truck mileage is impossible. All that can be done is to build up a formula based on actual average service under reasonably good conditions.



CONVENIENT TABLES FOR DETERMINING PROBABLE TRUCK MILEAGE.

"This chart is based upon such conditions. It gives the mileage that can be reasonably expected from a truck of any cost between $1,000 and $10,000 and any capacity between 1 and 6 tons.

"Simply lay a straightedge across the chart as indicated by the dotted line, and column 'C' immediately gives the 'expectant mileage.'

"For example, what is the expectant mileage of a 2-ton truck costing $4,000?

"Connect the 2 (column A) with the $4,000 (column B), and the answer is, 'Nearly 63,000 miles,' in column C.

"This chart is not based upon the 'very best roads' nor upon the 'very best care.' It should, therefore, be possible to get even more than 63,000 miles from such a truck under the best of conditions. Under poor conditions such high mileage cannot be expected.

"If you now have a truck you will be interested in learning whether you are 'beating' this chart or if it seems to exact an extremely high mileage. Just lay a straightedge across and see."

Holds Expansion Joint in Place

By Guy Bonney, Baltimore, Md.

On a concrete road built by the Baltimore city water department, which was part of a new system of roads made necessary by the new dam, expansion joints were placed every 25 ft. apart.

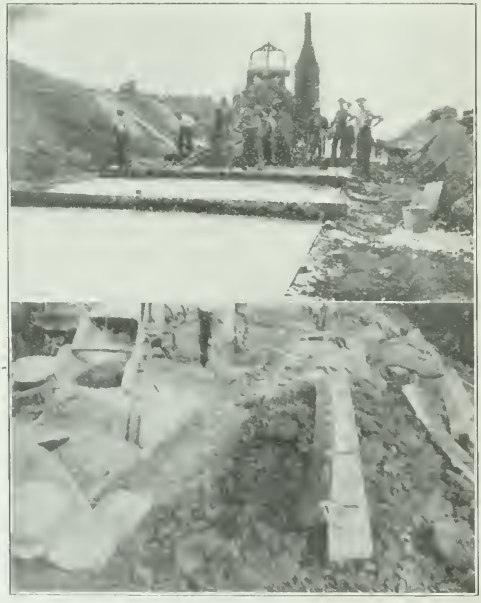
The joints were formed by a pair of soft steel plates, between which was a piece of asphalt felt; each plate had lugs to form the band with the road slab.

To hold these places to proper line and grade and to allow the finishers to work over the joint, the contractor made a simple device which was effective and cheap, requiring only a 2-in. board, six strap hinges and a few bolts.

The board was long enough to reach clear across the roadway; one edge was cut to conform to the crown of the road, and at each end of the board was nailed a pair of wooden brackets, spaced to rest on the side frames of the slab and extending ½ in. below the cut edge of the board; one nail in each bracket, and driven partly into the road forms, held the board in place and ½ in. above the top surface.

Six 8-in. strap hinges were fastened to the board with their ends extending 3 in. below edge of same. Small bolts were used for the fastening, and the upper or outside strap of each hinge had one bolt passing thru it and the board; this bolt formed the clamping power and was placed near end of strap.

The holders were loaded with the plates on a bench. The plates were spaced ½ in. below the edge of the board with small blocks. The clamping bolts were then tightened and

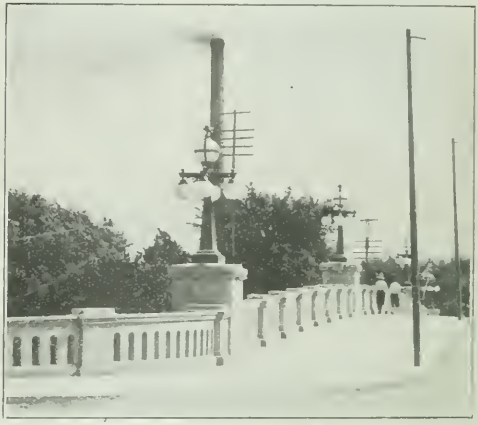


PLACING EXPANSION JOINTS IN BALTIMORE ROAD. LOWER VIEW SHOWS HOW JOINT IS CLAMPED TO BRIDGE.

the hinge ends did their work well. The next step was the placing of the loaded boards at the required spacing. The removal of empty holders was easy, after concrete had set around the joints enough to insure no settlement of plates. It required the loosening of the one bolt in each of the four brackets. The holes left by hinge ends were filled by the finishers. Six boards were sufficient to keep the work going.

Ornamental Lighting for South Bend

After a failure of merchants to agree as to the operation of a co-operative system of street lighting in the down-town districts of South Bend, Ind., the city took over the illumination of this district late last year. The agreement made between the city and the Indiana & Michigan Electric Company, which



ONE OF SOUTH BEND'S NEW ORNAMENTAL LIGHTS.

supplies the necessary power, provides for the illumination of 214 lights, which are to be paid for at the rate of $45 per cluster per year and maintained by the lighting company.

Approximately forty arc lights have been eliminated by this agreement, and in their stead now stand the more satisfactory, and certainly more attractive, cluster lights. Each cluster contains five lights, four of them of 60-candle power and the single top light of 100-candle power. All of the clusters are similar except those at what are known as dead ends. At the end of each string of clusters the top light is of 250-candle power.

All of the five lights burn from the first darkness until midnight, but special provisions are made so that the top light of each cluster burns all night. This relieves the city of the necessity of relying on an occasional uncertain light for illumination during the late hours in the down-town section.

The accompanying illustration shows the new posts on the North Michigan street bridge, just at the edge of the business district.

Continuous Heat Raises Water Consumption

That long-sustained heat waves have a cumulative effect on water consumption is proven by the records of the Denver water department taken during the summer months. A six-day rise in temperature during July showed a daily consumption of 75,000,000 gal., a considerably higher figure than was reached on other warmer days which were not a part of a sustained hot spell. The maximum water consumption of the city of Denver last year was 77,500,000 gal.

Improved Oil Treatment for Roads

A new method of oil treatment that does away with the objectionable features of a newly oiled road is advocated by the New York highway commissioners. This process, which costs about $25 per mile, consists of an alteration of the material used to flux the asphaltum or pitch base. The flux used has about 50 per cent. of light volatile oils, which evaporate in about two days' time.

Personal

George D. Willets is now city engineer of Galveston, Tex., succeeding A. T. Dickey.

G. M. Lorraine, formerly city engineer of Orland, Cal., has been appointed city engineer of Alhambra, Cal. He takes the place of Charles Hewes, now city manager.

W. R. Koonce, former highway engineer of Houston county, Alabama, has been chosen to fill the same office in Pike county, of that state.

R. W. Whitaker was recently appointed city engineer of Bakersfield, Cal.

C. E. Johnson has been appointed city engineer of San Bernardino, Cal.

Arthur H. Blanchard, professor of highway engineering at Columbia University, was recently appointed consulting highway engineer to the Board of Water Supply of the city of New York.

Mark M. Trumbull, formerly in the service of the Illinois State Highway Commission as concrete and steel bridge specialist, is now assistant city engineer of Ottawa, Ill., and superintendent of highways for LaSalle county.

Charles M. Upham, Georgetown, Del., has been made chief engineer of the State Highway Commission. Mr. Upham was formerly county engineer of Sussex county and chief engineer for the Coleman du Pont Road, Inc. George W. Francis, Wilmington, a graduate civil engineer from Delaware College, has been appointed secretary to the commission.

Robert C. Terrell, of the department of civil engineering at the University of Oklahoma, has been promoted to the rank of associate professor, in charge of the new department of highway engineering as organized at that school. The new department is to be a branch of the School of Civil Engineering in the College of Engineering at the university. Mr. Terrell was formerly commissioner of public roads of Kentucky.

Charles H. Hurd, member of the Indiana Sanitary Commission, and formerly chief engineer and vice president of the Indianapolis Water Company, has been selected by the War Department as consulting engineer to take charge of the reconstruction of the water supply and sewage disposal plants at Fort Benjamin Harrison. The work involves the construction of a new 3,000,000-gal. water supply system to care for the men expected in September.

Dudley T. Corning, assistant engineer, Bureau of Highways and Street Cleaning, Philadelphia, Pa., has been appointed division engineer in the newly created Bureau of Street Cleaning. Mr. Corning was formerly civil engineer with the Cambria Steel Company, Johnstown, Pa., and manager of its subsidiary concerns, the Cambria Inclined Plane Company and the Manufacturers' Water Company.

George A. Duren, who has recently been appointed state highway engineer of Texas, was formerly resident engineer of the San Antonio & Arkansas Pass Railway, in 1903. Mr. Duren has made a careful study of roads and bridges in Germany, France, Belgium and England.

C. E. Hickok, recently with the United States Department of the Interior, has been appointed city engineer and superintendent of streets of Alameda, Cal.

Charles A. Mead, engineer of bridges and grade crossings for the Board of Public Utility Commissioners, New Jersey, has been placed in charge of the highway bridge work of the State Highway Commission, under statute provisions allowing such co-operation between state departments.

Ernest P. Goodrich has been appointed chairman of a subcommittee under the Council of National Defense, to investigate certain matters concerning cantonment location, design and construction. He has also been appointed director of the Bureau of Municipal Research of New York City and director for New York City of the military census of New York State.

James H. Von Wagenen has moved his headquarters from Washington, D. C., to Danforth, Me., in order to be near a number of surveying parties that are making surveys of the international boundary line between the United States and Canada. Mr. Von Wagenen was formerly one of the assistant engineers of the Illinois Highway Commission.

Mr. J. W. Hruska, who was formerly superintendent of highway work in LaSoeur county, Minnesota, is now engaged in a similar capacity in Waseca county, of the same state.

James H. Herron was made president of the Cleveland Engineering Society, taking office at its thirty-seventh annual banquet, on June 12, 1917. Mr. Herron has held a number of high positions in the engineering field, having been metallurgical engineer for the Detroit Steel Product Company, and, previous to that time, was commercial manager of the Bury Compressor Company, Erie, Pa. Mr. Herron is a member of the American Society of Mechanical Engineers, American Chemical Society and the American Society of Automobile Engineers.

Harold McCormick was recently made county engineer of Rathen county, Virginia, having resigned from the same office in Pike county, Ohio, to make his new connection. Mr. McCormick has been succeeded as engineer of Pike county by Joseph G. Bulmer.

W. S. Baver was recently made manager of the Clarksburg Engineering Company, a new organization of consulting, civil and mining engineers, which succeeded Alstetter & Wooters, of Clarksburg, W. Va. Mr. Baver was formerly assistant sanitary engineer of Johnstown, Pa.

Forrest J. Alvin, general manager of the United States Motor Truck Company, of Cincinnati, presided at a meeting recently held at the company's factory for the purpose of discussing motor truck construction features. Speakers at the meeting were: J. R. Phillips and Walter Jones, both of the Sheldon Spring and Axle Company. Many manufacturers and dealers in motor trucks in the Cincinnati district were present at the affair, which is one of a series of educational "get-together" meetings that are being held from time to time by the United States Motor Truck Company.

Meetings of Organizations

September 24-29, at Santa Rosa, Cal.—League of California Municipalities and Annual Public Welfare Exposition of municipal streets, street and road-making machinery. F. J. Erb, director of exhibits, Pacific Building, San Francisco. H. A. Mason, Secretary, 1120 Crocker Building, San Francisco.

September 27 to 29, at Chicago Norske Club, 2346 North Kedzie Boulevard, Logan Square, Chicago, Ill.—Informal Congress and Reunion of American and Canadian Engineers and Architects of Norwegian Birth or Descent. Joachim G. Giaver, chairman of local Chicago committee on arrangements.

October 17-18, at St. Cloud, Minn.—League of Minnesota Municipalities. Richard R. Price, Secretary, University of Minnesota, Minneapolis.

November 12-16, at New Orleans, La.—American Society of Municipal Improvements. Chas. C. Brown, Secretary, Indianapolis, Ind.

November 21-24, at Detroit, Mich.—National Municipal League. Headquarters, Hotel Statler. Clinton Rogers Woodruff, Secretary, 703 North American Building, Philadelphia.

MACHINERY AND SUPPLIES

A Pneumatic Road Scarifier

As an adjunct to the economical maintenance of earth, gravel and macadam roads, a Chicago manufacturer has perfected a novel pneumatic road scarifier. This scarifier is made up as an integral part of an oil engine driven road roller and is applied in such a way that the weight and power of the roller are most efficiently applied to the work.

The Austin-Western scarifier unit consists of a cylinder attached to the rear end of the roller frame, to which pressure

AUSTIN-WESTERN PNEUMATIC ROAD SCARIFIER.

can be applied from air storage tanks mounted on either side of the cylinder. The cylinder is connected to the scarifier by a connecting rod pinned at each end, which prevents any straining or twisting of the scarifier attachment, transferring undesirable vibration or strain to the cylinder itself. The scarifier attachment proper consists of a hinged frame hung on the rear end of the roller frame. This hinged frame is spanned by a steel yoke attached to the power end of the piston connecting rod, so that the downward pressure of the piston will force the scarifier teeth into the ground and keep them there during work, and by a simple reversing cock the pressure can be applied to the lower end of the piston and quickly raise the teeth out of work.

Cut Depth Regulated by Air Pressure

The air pressure is maintained in the tanks by a small compressor mounted on the top of the engine cylinder and operated by the engine from the crank shaft. A few minutes running of the compressor is sufficient to raise the air pressure in the tank up to 120 lbs. per square inch, which is ample for operating the scarifier, and a safety valve is supplied in the tanks, which blows off at that pressure. The tanks are tested to 300 lbs. pressure, so that they are absolutely safe. Tanks are also fitted with a pressure gauge and the compressor is fitted with an automatic cut-out, so that when the regular working pressure is reached the air compressor is automatically cut out, thus saving wear and tear and loss of horse power.

Operation Practically Automatic

As there are no hose connections or hinged joints in the scarifier described, there is no danger of air leakage, and it is claimed very little skill is required for successful operation and care of the machine. Movements of the scarifier casting are practically automatic. After the machine has once been lowered into the work, a fixed depth of cut is maintained without further attention. The air pressure provides a spring of perfect elasticity, which protects the roller and its parts from strain and vibration, even on heaviest work.

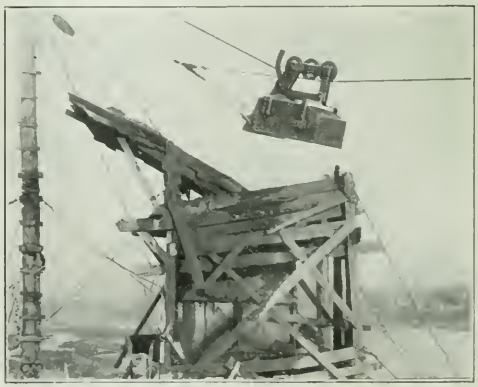
Special attention is called to the fact that the seven tynes or teeth are adjustable separately for wear and depth of cut, and are so attached that the loosened material does not clog up in front. The road wheels at each end of the scarifier simply act as guides or guards, so as to adjust the depth of cut and maintain an even and uniform work and to prevent the teeth from diving when soft material is met with.

Cable-Way Excavator

Application of the slack cable-way bucket here illustrated has resulted in a material decrease in the cost of carrying sand and gravel from a river back to a washing plant. This bucket is said to be very simple in construction and ruggedly built.

A curved latch carrying a heavy iron hook holds the load in the bucket during transmission. This latch is so pivoted that the greater part of the weight falls in front of the pivot center, insuring quick and sure locking of the bucket.

As the carriage is always erect over the bucket and is rig-



SLACK CABLE WAY EXCAVATOR WITH 31½ FEET CLEARANCE READY TO DUMP LOAD.

idly connected to it, the sheave bearings are not exposed to grit and dripping water, a fact which adds materially to their life. The bucket itself is of one-piece construction, with the exception of the back, which is riveted in. Loading is greatly facilitated by the smooth surface that is at all times presented.

Low Construction Cost Claimed

Construction costs incident to the installation of this excavator are quite low, owing to the simplicity of the rig. A considerable part of the total cost is consumed in the construction of the tower, which should be high enough to give a fall of from 10 to 15 ft. for each 100 ft. of travel.

Power may be supplied by steam engine hoist, by a gasoline engine double-drum hoist, or by an electric motor, where low cost power is available. Approximately 1-h.p. per cubic foot of bucket capacity can be figured where steam or electricity is used, and slightly more where gas-engine power is applied.

Portable Rock Crusher

The amount of haulage necessary on the average macadam or concrete paving job has been materially lessened by a portable rock crusher, which is light enough to be transported easily, but has the strength necessary to crush the hardest rock used for paving. This crusher, which is here illustrated, is known as the "Acme."

In the main, the Acme Crusher consists of a 50-ton portable bin mounted on steel wheels; a solid steel jaw crusher carried on an all-steel truck; and a folding bucket-elevator to carry the crushed stone from crusher to bin. In transporting the rig the bucket elevator is folded back over the crusher, the bin truck then being hooked up to the crusher truck and transported as a trailer.

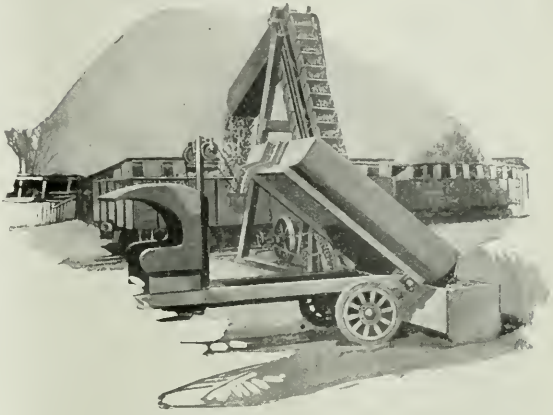
One of the special features of the "Acme" outfit is the fact that the crusher parts are made of open hearth steel. Jaw and lever are cast, while shaft, eccentric and roll are made of special carbon steel, hammered and turned to size. It is this feature in particular that makes the crusher especially strong in spite of its light weight.

Several sizes of this portable crusher are manufactured, these having capacities of from 8 to 300 tons per hour.

Automatic Car Unloader

One of the latest devices for unloading and loading sand, gravel, crushed stone, slag or other loose material for road work operates on the reciprocating bottom principle in conjunction with a chain bucket. An all-steel feeder, which fits between the ties under the car to be unloaded, is fitted with an engine-driven bottom plate, which moves back and forth a distance of 11 in. with each stroke of the crank shaft, carrying material out with each stroke and delivering it into the chute which carries it to the buckets on the elevator. The material is carried in a continuous stream to the buckets, filling them evenly to nearly their full capacity. The buckets of the elevator are made from sheet steel and are 16 in. wide, while the feeder is but 12 in. As there are always two buckets underneath the end of the chute of the feeder, it is impossible for any material to be discharged into the bottom of the pit.

Power is furnished to the elevator by an 8-h.p. engine, which is connected to the jackshaft by a steel roller-bearing chain, thereby eliminating all belts. Control of the elevator is secured by a friction clutch on the engine shaft. A spiral jaw clutch on the jackshaft allows the feeder to be started or stopped at will.

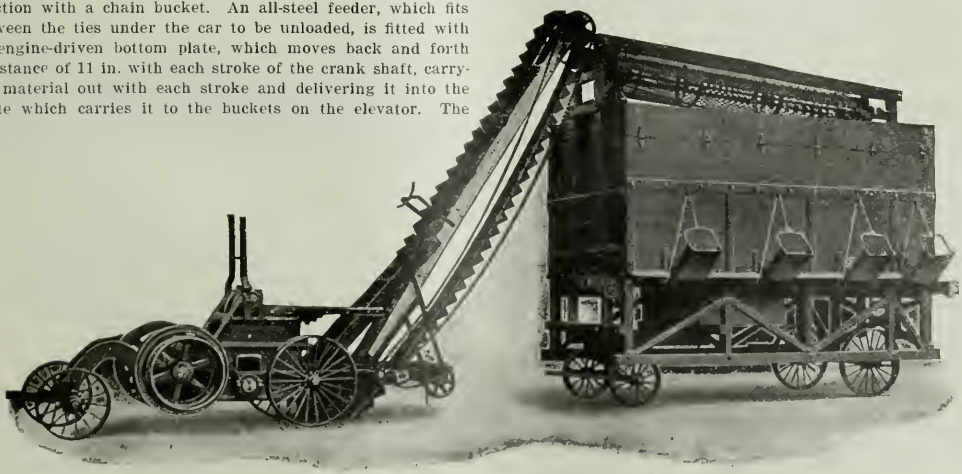


AUTOMATIC CAR UNLOADER.

Their 25-ton wood bin is easily erected and taken down. The three large openings in the bottom provide for quick loading, only 15 to 20 seconds being consumed in loading a two-yard dump wagon.

Counterbalanced Concrete Chute

Concreting of large areas has been put on an efficient basis thru a system of counterbalanced chutes recently perfected. With these chutes the economical working radius is greatly increased and the point of discharge is easily shifted up and



FIFTY-TON PORTABLE CRUSHER CONNECTED READY FOR WORK.

down the tower. By the use of counterbalanced structural steel sections the entire weight of two or three chutes can be supported by a single steel tower. As the sections and tower are structural steel, they are erected and dismounted easily, and are a valuable part of a contractor's permanent equipment.

Claim is made that a gravity plant of the kind described will save at least five men where the concrete to be placed per hour amounts to 10 yds. On a 20-yd-per-hour job, 10 men

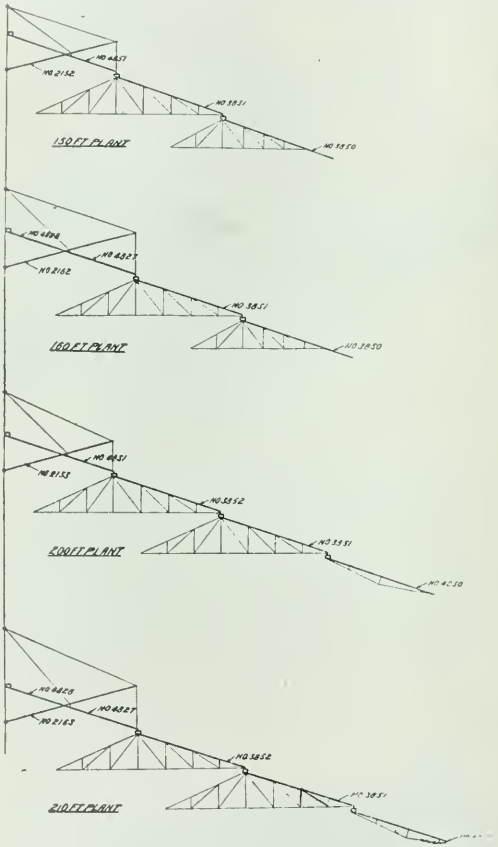


Diagram of Different Length Combinations of Concrete Chuting Trusses

could be dispensed with, as compared with the older concrete placing methods.

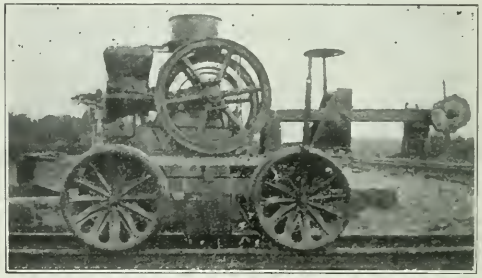
It is also found that properly mixed concrete is handled to better advantage in the chute than the sloppy too-thin sort. This stimulates the use of concrete mixed to a plastic consistency. In addition to the advantage given, the counterbalanced system entirely does away with wheeling over a green concrete floor, which so often permanently injures the structure.

The accompanying diagram shows how the counterbalanced sections are suspended to make chutes of different lengths.

Gaining Machine Replaces Hand Labor

More bridge timbers can be framed in a day, it is claimed, with a recently invented power framer, than could be handled by six skilled adze men. The new machine is especially adapted to the work of framing ties and guard rails for railroad bridges, but can be used on practically any timber framing job.

As illustrated, the entire machine is made up as a compact unit, mounted on narrow gauge car. Power is applied



POWER GAINING MACHINE.

by a 4-h.p. gasoline engine, this power being transmitted to a cutting head by belt. The arm on which this head is carried can be adjusted to any depth of cut by means of a screw wheel regulator.

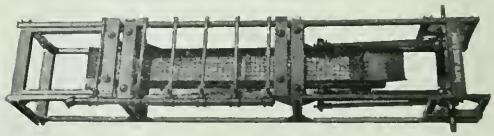
A second narrow gauge car running on a truck at right angles to that which carries the machine is used as a bed for timbers being cut.

In starting on a job the arm of the gaining machine is set for a cut of proper depth and clamped to hold the cut. The machine is then moved up to the work and thru the cut by means of a hand lever attached to one of the wheels of the car. Each cut made by the head is 2 in. wide and very clean. After each one the material car is moved a distance of 2 in. and a new cut made until the proper width of cut has been obtained. By repeated trips of the cutter, any depth or width of mortise can be secured.

This labor saver was invented by J. E. Toohey, of Grand Rapids, Mich.

A Compact Gravel Screen

The compact shaker sand-and-gravel screen here illustrated is 18 ft. long, 3 ft. 2 in. wide and 3 ft. 8 in. high, and has a daily capacity of 400 cubic yds. It is of steel construction, self-contained and readily portable, as it weighs but 3,600



NEW SAND AND GRAVEL SCREEN.

lbs. equipped with the spray washer. The top, of 2-in. mesh, takes the oversize; the second is of ¾-in. mesh; the third mesh is 4 per inch, and is for roofing gravel; the fourth is 10-mesh for topedo sand; and the last of 24-mesh takes fine sand. These screens, which are made in 400 and 600-yd. units, operate at approximately ½c per yard for power.

Replacing Men on Maryland Job

Unusual factors forced the contractors constructing the Salisbury-Ocean highway in Eastern Maryland to replace men with machines wherever such a substitution was at all possible. Labor was hard to find, and owing to unpleasant work-

ing conditions, chief among which was a plague of mosquitoes, it was extremely difficult to find men who would stay on the job long enough to be really useful. Teams were exceedingly hard to get.

Owing to a lack of roadmaking materials in the neighborhood, this 13-mile road was built of concrete, another feature which helped cut down the hard labor. Specifications called for a single course highway, 14 ft. in width, with 5-ft. shoulders, making the overall width 24 ft. A 1:2:3 mix was used, this being laid 7 in. thick in the center and 5 in. thick at sides, all on a flat subgrade. Expansion joints were of Barrett roofing and were spaced 60 ft. apart.

Getting Material to the Work

Local conditions made the question of bringing up materials a rather complex one. Most of the work could be reached only by hauling over the subgrade, which was of a soft sand or loam that made cartage extremely difficult. For this reason any plan of haulage by team would probably have failed, even if teams in sufficient numbers had been available. A much more efficient plan of handling the material was worked out by the McNerney Constrnction Co. (Contractors), of Canton, Pa., who had the work in charge. This plan provided for the carriage of stone, sand and cement from a railroad which paralleled the new road at a distance of half a mile. Along this railroad track three base points were selected, work being carried on from one point at a time.

At each point in turn a ten-car railroad siding was laid and an unloader installed. A narrow gauge track was then laid parallel to the siding, this being so placed that the unloader could easily handle the materials from the flat cars to the industrial dump cars. The industrial track looped back to the road work, the rails being laid down on steel ties in the middle of the subgrade. Sand and stone were dumped on either side of the track, leaving room for forms at the edge. Cement piles were spaced 50 ft. apart.

Efficiency methods were carried thru every phase of the work. A Koehring No. 16 mixer was used, this being supplied wtih material by specially designed push cars. These cars, two in number, were built of steel, with a partition extending the entire length of the body and dividing it into bins. For the proportion desired the ratio in this case was 2½1, but the partition was made removable, so that other mixes could be measured. Loading at this end was done by hand shovelers, stone going into the large bin and sand to the small one. Two bags of cement were used to each carload of sand and stone. A double track beginning at a point about 10 ft. from the mixer provided for switching the loaded car past the empty.

About 30 men were kept busy at the work of mixing the concrete and finishing the work. These were divided as follows:

Foreman	1
Engineer	1
Fireman	1
Shovelers (stone)	8
Shovelers (sand)	4
Car pushers	3
Charging hopper	2
Placing concrete	3
Template men	2
Finishers	2
Utility man	1

A total of nearly 140 men were employed on the job.

Loading Machine Lowers Costs

As a result of replacing slow, expensive hand shovelers with a loading machine, a large manufacturing company reports that it has effected a saving of a little more than 15 cents per cubic yard on the sand and gravel handled. This saving is exclusive of supervision and overhead charges, showing merely the difference in economy between the men and the machine.

Carefully compiled cost records kept by this concern compare as follows:

COST OF LOADING BY HAND LABOR

Loading wagons, 8 laborers, 3 yds., 13 min. at 25c	$0.435
Loading auto truck, 8 laborers, 2½ yds., 10 min. at 25c.	.415
Cost of auto truck at $1 per hour	.160
Cost per 5½ yds	$1.010
Cost per yd	.184

COST OF LOADING WITH MECHANICAL LOADER

Loading wagons, 2 laborers, 3 yds., 4.8 min. at 25c	$0.040
Loading auto truck, 2 laborers, 2½ yds., 4 min. at 25c	.033
Cost of auto truck at $1 per hour	.066
Power at ½c per cu. yd	.028
Oil, grease, interest on investment	.010
Cost per 5½ yds	$0.177
Cost per yd	.032
Cost per yd., hand labor	$0.184
Cost per yd., machine	.032
Amount saved per yd	$0.152

An additional saving was made on this work, due to the fact that a wait of 10 to 30 minutes between loads, as it existed with the old method, was entirely done away with. Elimination of this wait resulted in a saving of from 20 to 60 cents per load or from $3 to $9 per day. The expense incident to time lost between loads was reduced by about 75 per cent. with the installation of the machine.

MECHANICAL LOADER CARRYING GRAVEL DIRECT FROM PILE TO TRUCK.

Loads Direct from Pile to Truck

As shown in the illustration, the loader used in making the comparative cost tests consists of a gas-engine operated bucket elevator, mounted on a substantial four-wheeled steel truck. Electric motors are supplied where this form of power is preferable.

A patent crowding device with which the rig is equipped pushes the elevator medium into the material 30 in. without moving the wheels of the truck, making the machine dig as well as elevate and eliminating the necessity of laborers shoveling the material into the buckets. The elevator medium can be tilted down when desired.

Claim is made that these machines will load trap rock that will pass thru a 4-in. ring, sand, gravel, coal, coke, ashes, and any other material capable of being handled with a shovel.

Gasoline Tractor for Road Work

As a result of the application of the 6-cylinder gasoline engine to a road tractor, a small but quite powerful machine has been produced. It is known as the "American." This tractor, which is here illustrated, is powered with a 70-h.p. engine, and owing to the steady drive obtainable from this power source, will handle a string of loaded trailers with ease. Three steel wagons, each containing 15 yds. of crushed stone, made up the load at a recent trial of the tractor. This load of 25 tons was pulled up a considerable grade to the point where the crusher was located.

Transmission and Brakes

The transmission of the new tractor is of the selective type—three speeds forward and reverse—mounted on frame directly behind the motor. All shafts and gears are of nickel steel. Bearings are die cast of best grade of Babbitt metal. There are three (center) bearings on each shaft. All gears are extra large. The gear shifting mechanism is entirely enclosed in the oil-tight transmission case.

The brake drum is mounted on an extension of the secondary shaft just outside the transmission case. The brake is operated by the same lever which operates the clutch, being so linked that the action of releasing the clutch applies the brake.

The drive shaft is mounted on roller bearings carried in brackets bolted to the lower side of the frame. Mounted on this shaft are the steel drive gear and the chain sheave, the whole being entirely enclosed in a steel case, which protects the driving parts from injury and dirt.

Drive to the front and rear axles is thru an adjustable chain made from the highest grade of vanadium steel forgings. The feature of this drive is that the working surface is between the outside of the chain link and the pocket in the sheave wheel, and permits steering of axles without interference or loss of power each link is adjustable for stretch and wear and self-locking.

Semi-Floating Axles Used

The axles, semi-floating, are identical, and made entirely of steel, differing only in the method of attaching to the frame. The axle shafts are of nickel-steel, carried in roller bearings of ample size, four bearings used in each axle. The differential used in general automobile construction is here replaced by the chain sheave, which carries the differential pinions.

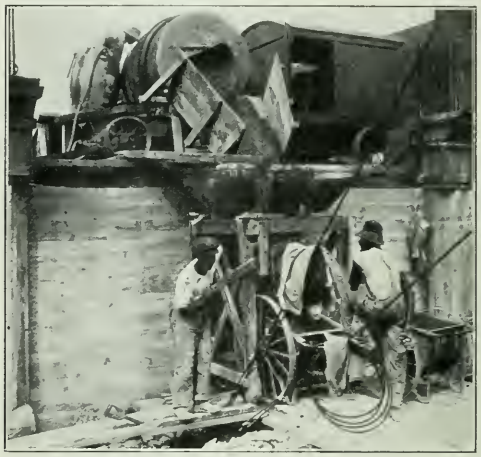
GASOLINE TRACTOR WITH TRAILER TRAIN.

The rear axle is mounted in a large ball-bearing fastened to the frame, thus always maintaining the relative position of axle and frame. The front axle is mounted to frame with a ball and socket joint; the axles are self-lubricating.

The wheels are provided with angle-iron rims fastened together by means of drop-forged cleats riveted across the face of the wheel at an angle of 22°. Each wheel has thirty spokes and eight pull rods, all of which are always in straight tension. The pull rods do all the driving, leaving the spokes to carry the load only. The face of the wheel between the cleats is left open to prevent clogging with mud or snow.

Portable Mixers Used to Serve Distributing Towers

The Chicago Junction Railway Company has under construction at Thirty-ninth and Canal streets, Chicago, a large general warehouse covering a ground area of 287x200 ft. The structure is to be five stories in height, with an unusually deep basement, and the George A. Fuller Co., executing the contract, are using three distributing towers as the principal



PORTABLE MIXER CHANGING HOPPER.

means of conveying the mixed concrete. Time is an important factor in the construction of this building, and as a means of speeding up the work the distributing towers are served by portable mixers.

For mixing the large quantity of concrete required in the footings and walls for the street foundation and the footings for the numerous central columns, two low charging mixers are used, one of 10 cu. ft. and the other of 16 cu. ft. capacity. After the street foundation walls were completed the mixers were mounted directly on these walls for supplying concrete for central foundation footings. When placed in this manner the mixers discharged directly into hoppers from which the concrete was gated into carts for distribution. The mixers were moved along the walls as the work progressed, so that it was not necessary to wheel any of the concrete a great distance. The accompanying illustration shows the manner of discharge from mixer to hopper and gating the concrete from hopper to carts.

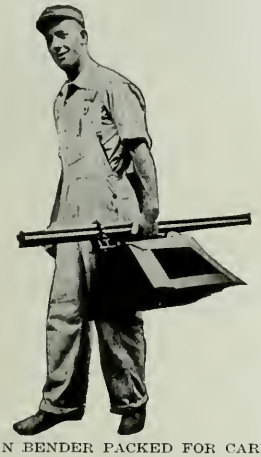
In explaining the use of these portable mixers as a means of increasing the rapidity of placing concrete on this large construction job, Mr. G. A. Sawyer, Jr., Chicago Manager of the George A. Fuller Co., said that he was first among the engineers of his company to use the portable mixers. In the construction of the Harvard University dormitory buildings the concrete had to be placed over a large area, and for his purpose he used portable mixers and moved them along as the work progressed. The economy effected was so great that he has since used them wherever construction work offered similar conditions.

Photos and statistics by courtesy of the Standard Scale & Supply Co.

Recently compiled statistics show that only 21 per cent. of the water used by the city of Chicago passes thru meters. The average daily water consumption in Chicago is 620,000,000 gallons, or about 249 gallons per capita.

Portable Vise Standard

A portable vise standard and pipe bender that can be used to advantage both on old and new work has recently been placed on the market. This combination tool is strongly made, the body being constructed of heavy sheet iron, se-



MARTIN BENDER PACKED FOR CARRYING.

curely riveted and well braced with angles. The legs are made of ¾-in. pipe and are widespread to give a firm working place. Legs are easily removable. Each standard is equipped with either a chain or hinged vise.

When pipe is inserted in the vise, to be either cut or threaded, the bender at the rear end acts as a guide. The bender will handle all sizes of pipe up to ¾ in. in diameter, and it is claimed will positively not kink the pipe. The legs

MARTIN BENDER READY FOR USE.

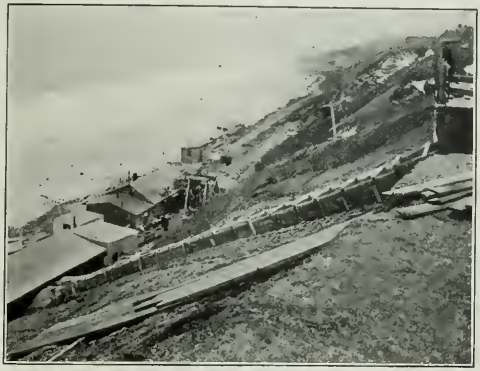
are so set that the stand can not be upset when threading pipe or in bending the largest size. The No. 16 gage side braces form a convenient place for hanging wrenches, cutters and other tools of a similar nature.

The device is known as the "Martin" Portable Vise Stand and Pipe Bender.

Material Chute on Shore Tunnel

The Milwaukee (Wis.) Water Department is having a special shore tunnel built at the new Linwood avenue intake off Lake Michigan. Owing to the difficulty of reaching Shaft No. 2 by either wagon or motor truck, a steel-lined material chute (see photograph herewith) has been erected to convey the cement, stone and sand from the unloading platform, at the hilltop, to the cement shed and the mixer platform at the base of the hill. This chute is placed on an angle of 30° 16′ 40″ with the horizontal. It is 90 lineal ft. in length, 46 in. wide by 21 in. deep, and is made of 2-in. plank, with bottom lining of 18-gage sheet steel.

Near the lower terminus of the chute, says L. G. Warren, the resident engineer, a two-way diverting branch was placed, and there a swinging gate enables them to divert the cement



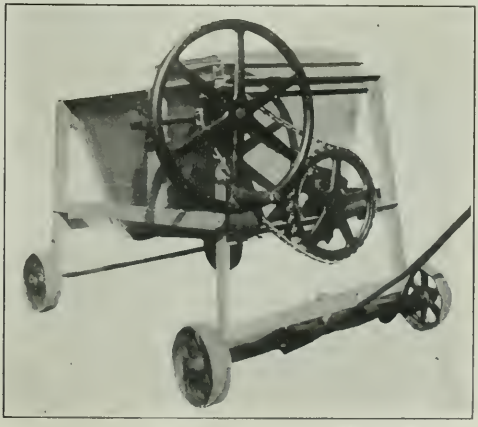
MILWAUKEE, WIS., WATER DEPT. SHAFT NO. 2, LAKE SHORE TUNNEL.

to the cement storage shed, or the sand and stone direct to the mixer platform. The unloading platform (note photo) is provided with a 6x6-ft. trap door, giving ready access to the chute. All materials except wet sand prove to flow readily on the 30° angle, but it requires a man to give wet sand a little extra impetus to get it to slide properly.

Grout Mixer Lowers Paving Cost

Claims of perfect uniformity in grout mix, at a much lower cost than has been possible with hand mixing, is made for a power-driven grout mixer, invented by A. W. D. Hall, City Engineer of Jackson, Mich. While the illustration shows a hand-drive arrangement, a 1½-h.p. gasoline engine is recommended as a saver of power supply.

One of the principle features of this machine is a paddle wheel at the bottom of the agitating chamber. This wheel,



GROUT MIXER AS OPERATED AT JACKSON, MICH.

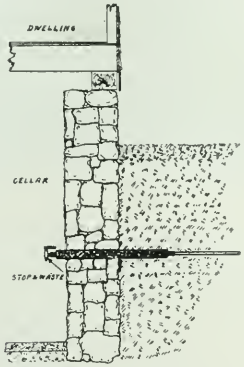
turned by the main drive wheel thru a chain, insures uniform mix.

Cement and sand are placed in a two-compartment hopper at the end of the mixer nearest the flywheel. These compartments each have a capacity of 1 cu. ft. Gravity carries the ingredients to the mixing chamber, at which point water is added. A hand-operated valve at the outlet regulates the supply of prepared grout.

It is claimed that the hand-driven machine will mix a batch of 1 cu. ft. of sand and 1 cu. ft. of cement in two minutes or less, while with the engine drive this time is reduced to 30 or 40 seconds.

Cement Coated Water Pipe

To protect iron pipe from corrosion at the point where it passes thru the cellar wall, a concrete coating is now provided. This keeps the pipe from direct contact with ground

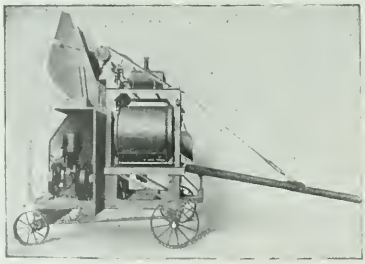


SECTION OF "CELLARWALL" CEMENT COATED PIPE.

water outside the cellar wall and protects it from condensation inside the wall. The pipe section as supplied is 3 ft. 6 in. in length, wrought iron, and is coated to a depth of ½ in. with neat cement. The device is known to the trade as "Cellarwall Service."

Portable Concrete Mixer

Several mechanical features which add to the efficiency of the small paving job have been perfected in a compact concrete mixer that is now being marketed. This mixer is de-



BANTAM CONCRETE MIXER.

signed especially for handling alley, driveway and small road jobs.

This new "Bantam" machine is a one-bag batch mixer and is equipped with an open-end pivot hopper, with dumping bar for quick charging. The compensating hoist sheaves, which raise this hopper, apply the maximum speed as the hopper approaches a vertical position. The hoist is equipped with an automatic knock-out which prevents damaging the hopper and permits the operator to turn his attention to other duties. The automatic water-measuring tank, similar to those installed on standard Ransome mixers, facilitates quick and efficient operation.

The paver discharges thru a 10-ft. distributing chute which is entirely clear and unobstructed by cross-roads of any kind. This gives the chute a clear swing of practically half a circle.

The mixer end of this chute is 3 ft. 11 in. above the ground, permitting a fairly steep slope when desired. An intermediate gate in the chute facilitates even spreading of the concrete.

The power unit is a 4 h.p. gasoline engine. A belt drive is used. The paver is regularly furnished without traction gear, but if desired a suitable traction gear can be provided. With the traction drive a 6-h.p. engine is installed.

Universal Sand Tester

Realizing that the value of sand as a building material is largely dependent upon its structure, a demand has been established among contractors for definite advance knowledge of the sand to be used. This knowledge is quickly and authoritatively supplied by a small sand tester that has recently been perfected. With this device, an absolute determination of grading is furnished, and an indication of the cleanness is given.

The "Universal" sand tester consists substantially of a graded series of standard mesh screens (Nos. 6, 10, 20, 35 and 65), placed in a series of communicating glass vials, as illus-

UNIVERSAL SAND TESTER.

trated. The whole arrangement of vials is water-tight, so that the wet test can be carried out.

For making the test a small metal measure is filled with the sand to be used, this measured quantity of material being poured into the top vial, which is then filled with water to a point above the first screen. The instrument is then shaken until the sample under test has been divided.

Determination of percentage is then made by marking on a record card the height of the sand deposit remaining in each vial. This height is marked in percentage on the card, so that the percentage of sand retained by each screen is read direct, making calculations unnecessary and giving an accurate and authentic record of each test.

FIRE DEPARTMENT

Chicago's Electric Fire Boats

Two boats of rather unusual interest form an important part of the fire-boat squad which for some years has been stationed in the Chicago river, protecting Chicago's river front. These are the twin boats, "Joseph Medill" and "Graeme Stewart," both electrically operated. Principal dimensions of the craft are: Over-all length, 128 ft.; beam, 28 ft.; depth of hull, 15 ft.; draft, 9 ft. 6 in. Steel construction is used thruout except for a small amount of inside finish of deckhouse and pilothouse. Water-tight bulkheads, water-tight hull compartments and strongly reinforced bows constitute construction features worthy of note.

Steam Turbines Supply All Power

While the boats are propelled by electric motors, the prime source of power on each is a steam turbine, the same one which supplies power to the pumps. This arrangement allows a maximum use of the equipment, as the pumps are not required when the boat is under full headway, and vice versa.

Two centrifugal fire pumps take care of the pumping requirements on each of the twin boats. These pumps are two-stage, and are each capable of supplying 9,000 gal. per minute against a pressure of 150 lbs. to the square inch. By means of a branch pipe arrangement the discharge of one pump may be connected to the suction of the other, so that the set is, in effect, a four-stage pump. With this connection a 5,000-gal. per minute stream is delivered at 300 pounds pressure. Coming from a 3½-in. nozzle, this stream has a tremendous fire-fighting efficiency.

Turbo-Generating Equipment

Power for each pump is supplied by a 660-h.p. Curtis turbine, each turbine shaft also carrying a 200-kilowatt direct-current generator. The electric power generated is carried thru suitable control apparatus to the two 250-h.p. direct-current motors, one being connected directly to each propeller shaft. As the motors are of the variable-speed reversing type, the movements of the boat are controlled with remarkable nicety. Independent turbine sets operate the exciters.

How the Boats Operate in Service

Getting under way with the electric fire boats is an extremely simple matter. The engineer starts his turbines, circulating and air pumps, while the captain turns the controller that regulates the speed of the screw motors. On the run to the fire all the power of the turbine is available for driving the boat, as the fire pump impellers are simply turning in their

HORSE-DRAWN AERIAL TRUCK, MOTORIZED WITH A 3½-TON GRAMM-BERNSTEIN TRACTOR, OPERATED BY THE CITY OF LIMA, O.

casings. Arriving at the fire, the engineer has only to open the sea cocks, letting water into the pumps.

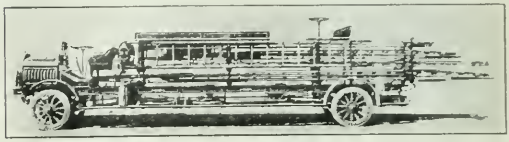
Electric operation of fire boats as applied in Chicago's twin installation has many features to recommend it. One important advantage of electric over direct steam drive comes from the fact that the propellers cannot race, even when rough going carries them clear out of the water at times. The motors used run at a constant speed, whether running fully loaded, partially unloaded or entirely free from load. Damage to propellers and to the boat itself is prevented in a great degree by automatic circuit breakers, which open the motor circuits the instant a certain degree of overload is reached. Thus in moving down the ice-filled river, if the propeller blade happens to strike a large block of ice, the motor automatically stops, saving the propeller from damage. In a similar manner the motors are stopped in case of a collision with a dock or another boat.

Dredge Spuds Moor Boats

On account of the fact that a considerable portion of the river water front is without dockage facilities (the buildings extending clear to the water edge), some means of positive, speedy anchorage had to be provided. For this service spuds designed somewhat on the order of dredge spuds were installed. Four of these spuds are provided, two forward and two aft of each boat, these being made of double thick steel pipe 18 in. in diameter, shod with cast steel points. Steam power is used for raising and lowering the spuds.

Harrisburg Buys Powerful Truck

Two powerful ladder trucks, both of the type here illustrated, have recently been added to the equipment of the Harrisburg, Pa., fire department. In these trucks power is applied at all four wheels, with the result that the front wheels pull just as strongly as the rear ones. Utilization of all power generated by the motor accounts for the wonderful showing of these Duplex trucks. Power wastage is practically elimi-



DUPLEX LADDER TRUCK, AS OPERATED AT HARRISBURG, PA.

nated. Applying the power in the Duplex with twice the effectiveness possible in rear wheel drive trucks gives the Duplex tremendous reserve power and makes impossible the stalling of the truck in hub deep mud or on steep hills.

"The Duplex is known in many fire departments as the truck that goes anywhere," said H. M. Lee, president of the Duplex Truck Company, of Lansing, Mich. "Fire chiefs who have installed the Duplex assert that it is the most dependable truck built; that it is always on the job."

MACK CHASSIS, EQUIPPED WITH HOOK AND LADDER EQUIPMENT, AS OPERATED BY THE CHICOPEE, MASS., FIRE DEPARTMENT.

VOL. LIII. — No. 3. **Municipal Engineering** SEPTEMBER, 1917.

Design, Construction, Operation and Maintenance of all Public Works

EDITORIAL CHANGES

Beginning with this issue Municipal Engineering passes under new editorial management. Some changes in the reading matter and in the form of its presentation will be observed in this issue and other changes are planned and will speedily become effective. Service to readers is the dominant thought in editing and publishing this journal. In line with this policy the editorial matter will be classified and presented under department headings which will form a regular feature of each issue. Here are the major section headings:

Water Works Design and Construction, Water Works Maintenance and Operation, Sewer Design and Construction, Water Purification and Sewage Treatment, Refuse Collection and Disposal, Pavement Design and Construction, Pavement Cleaning and Maintenance, Plant Units and Layouts, How the Contractors Are Bidding, Digest of the Essential News, Advance Information on Big Jobs, From Workers in Field and Office, Questions and Answers, Bridges and Buildings, Sales Engineering, Lights and Shades, Fire Engineering, and Contract News.

These headings are largely self-defining, but it will be appreciated that some words used must be interpreted broadly. Thus the word pavement is used to denote all hard road and street surfaces, whether in country or city. Special attention will be given to water works operation without neglecting design and constructional features. Water purification and sewage treatment will be handled in the same department because of the similarity of the scientific principles underlying these arts. The term refuse will cover all wastes except sewage, which is separately treated. Economical plant layouts will be regularly featured and new machines, devices and materials described. Bidding prices, always much wanted by contractors, will be given in each issue. The department entitled: Digest of the Essential News is a concession to the busy man who wants to keep up to date but must do his reading on the run. The Sales Engineering department will discuss the opportunities in this line for engineering graduates and will also discuss the approved and effective methods in this field; it will also present manufacturers' salesmen to the contracting and engineering public. The Lights and Shades Department will provide easy transition from the day's work to the evening's reading.

The minor section headings are: Personal Items, Obituaries, Coming Conventions, Catalog Reviews, Book Reviews, and Trade Notes.

Each of the major editorial sections will be regarded as a separate periodical. The sectional method of presenting editorial matter has much to commend it to the reader. It facilitates the finding of matter of interest to individuals and safeguards the various interests against lack of attention on the editor's part. This scheme is wholly for the reader's benefit, and for this reason the burden it imposes on the editor is cheerfully shouldered and borne.

For twenty-seven years Municipal Engineering has taken the lead in serving those engaged in the design, construction, operation and maintenance of engineering public works. The editor requests the cooperation of the interests addressed in making this paper even more of a mutual benefit institution than before. Since its continued success depends wholly upon adequate service, constructive criticisms are solicited and will be given immediate and careful consideration.

LEGITIMATE SUBSTITUTION

Just as manufacturers in many lines have substituted one material for another to keep down costs, engineers and contractors will do well to reconsider the relative desirability of the various materials of construction in the light of war-time costs and other conditions. For example, before the war, elevated water tanks of steel and concrete were about at a stand-off so far as first cost was concerned, the steel structure having the shade. As everybody knows, all iron products have greatly advanced in price, so that now the concrete tower and tank has all the better of the cost consideration. Some engineers will continue specifying steel structures, and this is their undoubted right. These structures are tried and true. Those who in former years have considered only the steel tanks as dependable might conceivably rule against any elevated water tank in the present condition of the steel market. They should reconsider the problem now. Since their first impressions were formed great advances have been made in concrete tank work. Certainly it is better to build a concrete tank than no tank at all. And that isn't all. The modern concrete tank is durable and water-tight. Water-tight tanks have been secured in past years without using special waterproofing materials. The best practice today, however, is to make such tanks fool-proof by applying an asphalt coating to the inner surface. This costs from ten to fifteen cents per square foot for labor and material. Following this practice the concrete structure may safely be specified by those whose previous experience has been wholly with the other type of structure.

In other lines legitimate substitutions may well be considered. Formerly a situation which called for riveted steel or cast iron pipe may now call for wooden stave or machine banded wood pipe, or, in some places, reinforced concrete pipe. Under very low heads in small aqueducts even vitrified clay pipe should be more carefully considered than heretofore. Similar substitutions will suggest themselves in other fields.

These suggestions are not made to encourage change for the sake of change or to advance the interests of one group of manufacturers at the expense of another. Nothing is further from our thought. It is the patriotic duty of the engineer to keep public works construction going on in war times and if legitimate material substitutions alone make this possible the substitutions should be made.

General Articles

Methods Employed in the Construction of Camp Grant Cantonment, Rockford, Ill.

At the time of writing, August 10, construction operations at Camp Grant are far advanced. The magnitude of the work may be judged from the fact that the cost is expected to reach four and a half to five million dollars. The extreme length of the camp is about two miles. The consulting engineer, who was first on the job, arrived on the 17th of June and the construction quartermaster on June 22. The work was actually begun on June 26. During the six weeks which have passed since that time, twenty million board feet of lumber have been erected and sleeping and feeding quarters put up for 6,500 men in the construction crew. During that period also eight miles of standard gage railway track have been laid in the camp, and 1,600 cars of material have been handled; 1,000 cars were handled during the first thirty days. "Speed" is the watchword on the job, and everything possible is done to expedite the construction operations.

The planning and building are proceeding simultaneously. Sketch plans are drawn up to cover the field locations, and detail plans are completed as the work progresses. This is a job on which it would have been folly to attempt innovations in construction methods, and so far as the engineering work is concerned, only well established methods have been employed. The interest in the work, aside from its national significance, lies in the fact that such an enormous body of men has been brought together from widely separated localities and has quickly become welded into a homogeneous working unit. As soon as one enters the camp, he is impressed with the spirit of optimism and of hearty co-operation everywhere prevalent.

The camp is situated at the junction of the Rock and the Kishwaukee rivers. The northern part of the camp is a mile south of the Rockford city limits. From the center of the camp to the center of Rockford is about six miles. The camp lies alongside the Chicago, Milwaukee & St. Paul railway, and ten big freight depots were speedily constructed along the railway. These were required to be completed by August 1, and before that time they were finished. They are of the familiar frame construction type commonly employed in freight depot construction, supported on concrete pillars of square cross-section. These pillars were separately cast in special forms and were erected after seasoning and curing.

Engineering work started with the making of a topographical survey of the site. The War Department at Washington furnished plans for certain units of the buildings, and these units were fitted to the topography of the site. This adjustment of the unit design to the ground was made on the ground. The camp consists of thirty-five of these units.

The design of the buildings is not gone into here, as these have been repeatedly published elsewhere. The buildings are of simple frame construction, not differing greatly from the wooden construction camp buildings with which engineers and contractors are familiar.

Water Supply and Distribution

The temporary water supply is obtained from three wells, about 130 ft. deep in the sand and gravel deposits underlying the camp. A temporary elevated tank, entirely of wood, was constructed for this temporary waterworks. These three wells are operated by gas engine driven deep well pumps of the plunger type.

The permanent water supply will be drawn from about eight wells, ranging in depth from 400 to 500 ft. These wells are at the northern end of the camp and lie on a bottom land on the east bank of the Rock river at about 10 ft. above the ordinary river stage. The wells will enter the St. Peter sandstone. Undoubtedly an adequate supply of water could have been developed from the sand and gravel deposits in the site on which the other wells are located. However, as there is an outside chance of contamination of such wells in this locality, considerations of absolute safety warranted putting the wells down to the St. Peter sandstone. A 12-in. casing was put down and sealed into the rock and a smaller bore continued into the water-bearing formation. The water in these wells rises under static head to the surface of the ground.

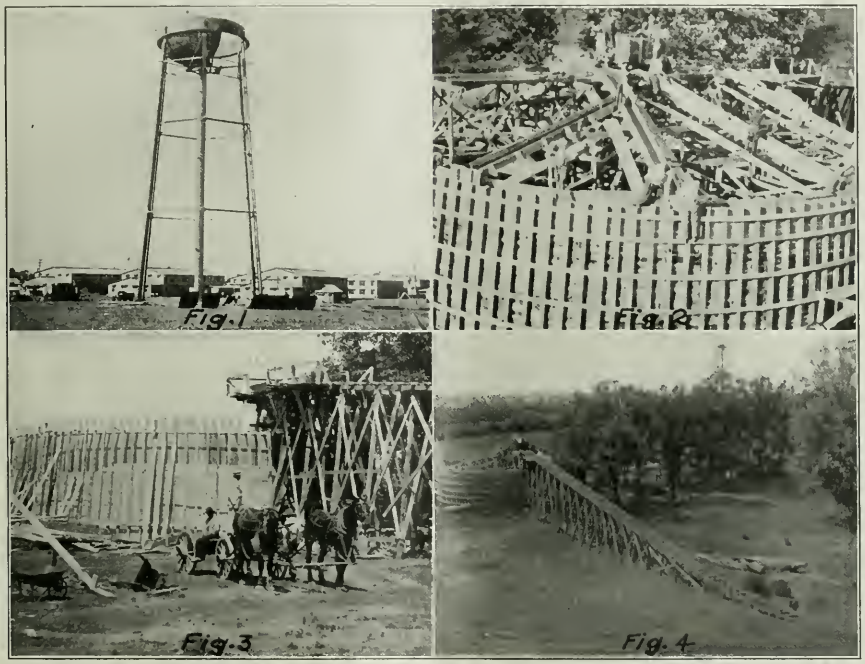
These wells will be operated on the air lift plan. Electric driven air compressors will operate the air lift. The water as pumped from the wells will discharge into a receiving reservoir 60 ft. in diameter and of 300,000 gallons capacity. The water will then be drawn from the receiving reservoir by four electric driven centrifugal pumps, discharging into a force main to the elevated steel tank of 250,000 gallons capacity on the camp site. This steel tank which was fabricated by the Chicago Bridge and Iron Co., is 140 ft. high from top of foundation to top of tank. Two of the centrifugal pumps are of American Well Works design and the other one of the Alberger design. Three of the pumps are of 1,000 gallons per minute capacity and the other one is of 750 gallons per minute capacity. The waterworks were designed for a final total population of from thirty-seven to forty thousand people. The air compressors used are of the Ingersoll-Rand design and the electric power employed is obtained from Rockford.

The construction of the circular reinforced concrete receiving reservoir mentioned is interesting with reference to the plant employed. The reservoir stands on the bottom land 10 ft. above the normal stage of the river, on one hand, and a bluff of perhaps 40 ft. in height on the other. This bluff is at the elevation of the highways, and the concrete materials required in the construction of the reservoir are hauled to a shed at the edge of the bluff, overlooking the bottom land on which the reservoir is situated. The mixer plant is part way down the side of this bluff, and the concrete materials are fed to it from troughs from the shed above. The mixer discharges into a car on an inclined industrial railway track, which extends from the mixer down to the level of the bottom land and then up again to the top of the form work on the receiving reservoir. The car is drawn back and forth by cables passing over the winding drums of a hoisting engine set on the bottom land. The concrete car used is of home construction, having ample capacity with a shear gate on either side opening by hand to discharge the contents of the car into troughs running to the forms. This is a very satisfactory layout and it works like a "charm."

The water supply pipe lines consist of 32,000 ft. of 12-in., 36,800 ft. of 10-in., 18,500 ft. of 8-in. and 14,000 ft. of 6-in. pipe. A small quantity of 4-in. pipe is used for the hydrant connections which are each 2 ft. long. Corey fire hydrants are used exclusively at this camp and all the valves used are of the Rensselaer type.

More anxiety has been experienced at the camp with the water distribution system than with any other feature of the

construction. This is due entirely to the difficulty in obtaining pipe. The first plan was to use machine-banded wood pipe, but it could not be obtained in the desired quantities within the time limits imposed by the order to have the job finished by September 1. At the time of writing, cast iron pipe was being received in large quantities, and it is thought that enough pipe will be delivered to take care of the first contingent of soldiers to arrive, at the very least. It may well be that all the pipe will be delivered in time for installation before the "dead line," September 1, is reached. Trenches are being excavated for the water mains and left open until the pipe arrives. This will make possible exceedingly rapid pipe laying after the pipe is delivered. All trenches, both for water and sewer, are being excavated by machines of Parsons & Austin manufacture. There are nine trenching machines on the job, seven engaged on sewer trenches, one on water and one on the service pipes. The service pipes range in diameter from ¾ to 2 in. Altogether there are 28 miles of water pipe, including the services, and there are 225 fire hydrants. One hundred and twenty-five carloads of plumbing supplies are on hand. There will also be twelve central heating plants. The Arnold Co., of Chicago, is in direct charge of the engineering on these heating plants.



CONSTRUCTION VIEWS ON CAMP GRANT CANTONMENT, ROCKFORD, ILL.

FIG. 1—250,000 GAL. TANK ON 6TH DAY OF ERECTION. FIG. 2—POURING LOW SERVICE RESERVOIR WALLS. FIG. 3—SERVICE RESERVOIR FORMS AND TRESTLE. FIG. 4—LOW SERVICE RESERVOIR FORMS AND TRESTLE TO MIXING PLANT.

Sewage Collection and Disposal

There are 22 miles of pipe sewers in the camp. These sewers are laid on comparatively flat grades, giving a velocity of about 20 in. a second. It is thought this will be a cleansing velocity, but if necessary, one or two flush tanks will be installed. These sewers discharge thru six outlets into the Rock river and thru one outlet into the Kishwaukee river. The latter outlet is down-stream from the camp, and thru it fully 60 per cent of the camp sewage will be discharged. Generally speaking, these sewers carry the house sewage only and surface water is admitted to them only in limited quantities. Complete surface drainage thru open ditches was not feasible, because of the peculiar lay of the land. The land has no pronounced natural slope, but is an undulating area overlying sand and gravel and containing numerous depressions and natural outlet. These depressions are in some cases being drained in a limited way into the sewer system. Submerged outlet pipe will be used at the sewer outlets to carry the sewage well out into the current of the river and give it prompt diffusion. These submerged outlets will be weighted in position with blocks of concrete. Ample dilutation for the sewage of the camp will be available, even at times of low water in the rivers. Thus it is not necessary to construct sewage treatment plants of any sort.

The handling of the engineering work on the sewer system is typical of the speed and boldness with which all moves have been made. Trenching machines were on hand before the first shipment of pipe was received, and it was thought wise to test out the sand and gravel soil underlying the camp to see how deep trenches could be dug without sheeting. When this experiment was undertaken, the sewer lines had been tentatively laid out, calling for some cuts reaching 10 and 11 ft. deep. It was early discovered that the soil would not stand without bracing at such depths, and it was, therefore, found necessary entirely to revise the layout of the sewage collection system, so as to call for shallower cuts at the expense of longer sewers. Within a half day after this decision

was reached, the entire sewage collection plan had been subjected to a root and branch revision. The new layout calls for an ordinary maximum cut of about 5 ft., and in these shallow trenches bracing is not required. There is one deep cut across a ridge reaching as high as 13 ft., and this had to be braced with great care, for the soil, while dry, has very little adhesion.

All sewer lines are laid with salt-glazed vitrified clay sanitary sewer pipe received from the Akron Sewer Pipe Co. Manholes are of two-ring brick construction with creosoted wood covers. The bottom of the manhole is made entirely of concrete.

Cost Keeping

While the quartermaster is in full charge of the work at the camp, it is necessary, of course, for Washington headquarters to have full knowledge of the conditions, so a daily telegraph report is made on each of the principal features of the work. A written weekly report gives a comprehensive view of the conditions, and weekly graphic sheets show the progress in delivering of materials and the construction of the various elements of the work. Cost data are not yet available for publication. Where speed was the governing consideration, costs have naturally taken a somewhat secondary position. This is due largely to the fact that thousands of men were employed who were total strangers to those in charge of the work, and it was inevitable that some inefficient men should be employed. As soon as the work was well under way, however, the undesirables were weeded out as fast as their shortcomings were discovered.

Under advice of the consulting engineer, careful daily studies are made to determine the field unit costs as a measure of the efficiency at which the work is progressing in different lines under the superintendents. These are taken daily to the superintendent, and any abnormal field unit cost is immediately given attention. The unit cost squad therefore became eyes for the superintendent and enabled him to watch the loose ends and lost motion of the construction in every line.

Where so much similarity of construction exists, it is only natural that a good deal of rivalry should spring up between the different construction crews, to see which can make the best record. This spirit is encouraged in the interest of speed and is supplemented by the cost and efficiency figures already mentioned. This expedient of determining field costs daily as a measure of the efficiency at which the work is progressing, introduced, as it has been, in a spirit of co-operation, has had a most salutary influence on the work from every standpoint. Mr. L. J. McHugh, C. E., is chief of the unit cost squad.

This system of checking up on output was even extended to the trenching machines. Daily records were compiled to show the output of each machine, and the best machine was rated at 100 per cent, and all others compared with this. An early result of this form of investigation was to dispose of one or two of the machines that had lost the "pep" of youth. The best record made by any trenching machine was made by the Austin "OO" which excavated 20,022 ft. of trench in 23 days, or about 872 ft. in a day. The best day's run of this machine was 1,820 ft. The average cut thruout this record-making performance was about 5 ft.

Road Construction

Within the camp there are 5½ miles of macadam road, 7 miles of gravel road and 9 miles of graded earth road. The macadam road is 18 ft. wide and has a thickness of from 5 to 6 in. at the sides and 7 to 8 in. at the center. The slope of the road section is 1 in. to the foot. Ditches along all roads are constructed with slopes of one in three on the roadside and one in one and one-half on the other side. The subgrade on the macadam roads has a crown of one-third inch to the foot. The gravel roads are 14 ft. wide and range in thickness from 6 in. at the sides to 8 in. at the center. The earth roads are 22 ft. wide and are given a slope of an inch to the foot.

Crushed stone for the macadam roads is obtained from quarries in Rockford and is shipped to the camp site in gondola cars. It is unloaded by a clamshell bucket operated by a derrick and a hoisting engine. The clamshell dumps into elevated hoppers which discharge directly into wagons and motor trucks. At the time of writing, one of these hoisting engine-derrick-hopper systems is in operation and another will soon be equipped, as it lacks only the derrick.

Water for sprinkling the macadam roads, which are laid and rolled in two courses, is hauled in sprinkling wagons of Case manufacture. There are five road rollers, of various makes, on the job.

The gravel for the gravel roads is obtained at the camp site where two gravel pits have been opened. Steam shovels excavate the gravel and drop it directly into ordinary dump wagons.

Other Plant Units

A fleet of from fifty to sixty motor trucks is in constant operation on this work. These are army trucks brought from the Mexican border. Captain Schleicher is in charge of the motor truck compnay, and it is a favorite pleasantry around the work to point out how completely he lives down the pronunciation of his name. These trucks are of Velie make and are giving splendid service. They are not of the dumping variety, but a false bottom was placed in each truck when it was being used to haul gravel and crushed stone. This false bottom had a total rise of about 14 in., and as the side boards of the box were removable, this served very well as the means of unloading. The gravel either slid down the sloping false bottom or was easily removed by a touch from a hand shovel.

Small gasoline engine driven buzz saws, made by the C. H. & E. Manufacturing Co., of Milwaukee, are employed in considerable numbers in sawing up lumber for use in building the various structures. These units are found thoroly reliable and very greatly expedite the work.

In the beginning most of the sewer trenches were backfilled with horse-drawn slip scrapers of wood. This method is being superseded at the time of writing by power-driven backfillers with the utmost satisfaction.

Gasoline for the various engines is hauled around the camp site in a tank wagon.

Purchasing Materials

In many cases the material is reserved for the contractors' use, and the maximum price for it fixed. He is notified of the arrangements made and must place the orders and see that delivery is made on time. For example, thru the lumber subcommittee of the General Munition Board, representatives of the big lumber associations of the country were assembled in Washington and agreed upon a price for lumber for these cantonments, this price not to exceed an average of $20 per thousand feet. Since many independent mills are not represented in the associations, the contractor is instructed to place at least 75 per cent of his lumber bill with the committee, and he is permitted to shop around for the remaining lumber required among the independent mills in his district. Other reservations of material were made by the government for the contractor. This included water and sewer pipe, hydrants, valves, pumps, plumbing supplies, etc. The machines used by the contractor are obtained by him as on any construction job.

Constructing Wooden Buildings

All the lumber being used at Camp Grant comes from northern Wisconsin and Michigan. It is unloaded onto the running gear of ordinary lumber wagons and hauled by horses to the points where it is required. Of course, the motor trucks also haul a great deal of this lumber.

Construction of wooden buildings was simple naturally because of the simplicity of the design. The interesting feature of the work was the routing of the various operations. The labor was subdivided in a way familiar to the those who have studied methods in the Chicago Stock Yards and in the Ford Motor factory. Thus one gang went along to stake out the site for a building; another followed and excavated for the foundations; another came along and placed the foundation timbers; another the flooring; another the studds; another the siding, and so on. Naturally these various units, going over the same kind of work every day doing again as they did the day before, became very expert and this accounted very largely for the speed in the construction of these buildings.

Special precautions are taken to safeguard the health of the men at the camp during construction and also to safeguard the buildings against fire. Captain H. C. Michie is in charge of the camp sanitation, sickness, vaccination and similar matters. Most of the wet garbage is hauled to Rockford for disposal. Army latrines are used and these are chlorinated and treated with fresh earth each day.

Special precautions are taken to swat flies and at times men have been delegated to swat flies around the cook and mess quarters. All meat consumed is stored, cooked and handled in the meat shop, which is thoroly screened in.

As a temporary safeguard against fire, fire buckets and barrels of water are kept at the corner of each finished structure. Fire extinguishers are also installed. One fire company is already on the ground and more are being installed. The camp is located on farm lands, including corn fields, oat fields and pasture lands. The oats have been cut down and stubble plowed at intervals to form a fire break.

Smoking is prohibited wherever building construction is carried on or material stored. Certain areas are designated where workmen may smoke at noon and smoking is permitted in a few buildings where constant watch is maintained. Open fires at or near building sites are prohibited. All rubbish is collected daily and removed to a place where it can be safely burned.

The kits of plumbers and steamfitters are inspected to make sure that they will not increase the fire hazard.

Personnel

Maj. D. H. Sawyer is Construction Quartermaster in full charge of all work at the camp. Lieut. D. A. Tomlinson is Adjutant. Alvord & Burdick, of Chicago, are the Consulting Engineers, and E. H. Bennett, of Chicago, is the Consulting Architect. Much of the admirable layout of the camp is due to his care and preliminary study of the necessary working conditions. Joseph Morrow, Asst. Chief Engineer of the Chicago & Western Indiana Railway, was "loaned" to the camp by E. H. Lee, Chief Engineer of that road. Mr. Morrow has had charge of the construction of all switch tracks and subways. Mr. P. Maloney, as Supervising Engineer, has charge of building construction, lighting and plumbing.

The Bates & Rogers Construction Company, of Chicago, are the contractors. There is not a sub-contractor on the job. The Bates & Rogers Construction Company are handling this work with their executive officers in direct charge and the work is occupying a considerable part of the attention of their organization.

Both Mr. Alvord and Mr. Burdick are spending all their time at Rockford and the water, sewer and road construction is going forward daily under their personal supervision.

Altogether there are about 100 experts at Camp Grant, each responsible for a part of the work. These men have cooperated in a manner that is an inspiration to an outsider. A strong patriotic feeling is everywhere in evidence and this includes the majority of the common laborers.

Influence of War on City Planning

In Europe, aviation has raised a whole series of new problems, in the planning of cities, many of which demand immediate solution. When in France last fall, the writer was taken out to one of the great aeroplane camps used in the defense of Paris and that was only one of a large number of aeroplane or balloon fields thruout France. These fields for training, maneuvres and storage require acres of continuous open space almost level in character and well drained. Around most cities such space is difficult to find and it is only by planning well ahead that adequate reservations can be made.

Landing Place for Aeroplanes.

The remarkable increase in the common use of aeroplane and dirigible balloons in Europe today makes it obvious that their use for commercial and pleasure purposes after the war is going to be perhaps as rapid in its growth as was that of the automobile. This presents the problem of providing convenient landing places for aeroplanes. In New York City, about the only place that has been considered desirable for landing is Governors' Island. With the thousands of aeroplanes that will be flying in this country within a few years, whether the war lasts or not, the problem of finding landing spaces, will become rapidly more urgent. In fact, the Post Office Department is now, in conjunction with the Aero Club of America, planning to select appropriate fields for landing in or near every important center. In France, most of the aeroplanes, from a standing start, go only some 100 or 150 yards before leaving the ground and then shoot up into the air at surprisingly sharp angle. They land easily in a 30-acre field. There are any number of places in New York, and in most of our other cities and towns, which would make ideal landing places if they were leveled off, and trees, bushes, wires and other obstructions removed. The problem of landing at night is perhaps the most difficult, and dangerous of all. In France, we found the landing places specially lighted by searchlights or by a peculiar formation of the surrounding lamps, so that seen from above, they are readily recognized. Then too, by day all sorts of special indications were used—whitewash or colored diagrams drawn on the ground, so that an aeroplane from a mile or two in the air could recognize the significance of the marks.

Advantage of Military Highways.

One of the most important problems for the city in time of peace, is the moving of crowds of people quickly from one place to another. Its importance is increased ten-fold in time of war. In France we saw everywhere parts of a great network of national military roads. They often go straight up and down over hills and valleys as did our old turnpikes, but always with the grades cut down to the minimum and with ample width and excellent surface. The roadways are never too narrow for two great motor trucks to pass each other at high speed; far different from our niggardly custom. Tho these national roads go thru the towns and cities, even in the larger cities they continue to belong to the national government and are paid for and maintained by it. They are the backbone of efficiency in the handling of people and goods about the country. Without them, France would have had the greatest difficulty in meeting the situation with which she has been confronted.

As for the railroads in France, here again we found men could be mobilized or handled in masses from one town to another with the greatest ease and speed. The special characteristics were ample approaches to the railway stations and extensive yards.

Increased Transportation Facilities.

In the transportation and handling of supplies, we found that great changes have been made in France since the be-

ginning of the war. In almost all of the freight yards that we saw, extensions were being made, new terminal tracks being put in, huge new warehouses being built, all with a view to handling war supplies quickly and without waste. At Marseilles we saw a great new classification yard along the new docks that the city is now building, rendered necessary by the trade that has come to the port on account of the war.

We went over the ports of Marseilles, Bordeaux, Rouen and to some extent Havre, but we hardly recognized them, so much had they been changed; the ports being doubled, trebled, and even quadrupled in size and even at that, ships waiting at anchor for days and weeks outside the port for a chance to unload. It was a condition of things that troubled us a great deal, for we realized that hardly a city in America was prepared to meet emergency conditions in like fashion.

Handling of Materials.

The thing that probably impressed us most in the handling of goods both along the waterfront and in the local terminals, was the extensive use of handling machinery. Even in the small villages, the freight yards were equipped with cranes and other handling devices, while in the larger yards and along the docks almost nothing was done by hand. Any mechanical device that would save labor was more than paying in its way, as it released men for services at the front.

The handling of foodstuffs for the civilian population is a problem to which France has given careful thought for a good many years. Every city, town and village has its municipal retail markets in big halls open at the sides, where stalls are rented to the little dealers at the minimum economic rental. This gives the city a chance to control not only the healthfulness and quality of foodstuffs, but also the maximum prices, all of which has proven a most effective means of keeping down the high cost of living during the war. More than that, however, there has been a very strong tendency of late years in France, as well as in other European countries, to develop public wholesale auction markets and a number of big retail markets have recently been changed for the most part from retail to wholesale use, all of which tends to keep down costs.

Many Housing Improvements.

In housing, we were astonished at the striking development which has taken place since the war began. We found in Limoges for example, that some six acres of four and five-story tenements in the heart of the city had been razed to the ground. At a cost of a great many millions, the city was going ahead in the midst of war times to lay out new and broader streets and rebuild the district along modern city planning lines. In Marseilles, we found fourteen and a half acres of old six and seven story tenements in the center of the city already torn down. At a cost of something like forty million francs, the city was laying out new broad streets and open spaces, erecting new buildings of a modern character all as a matter of "preparedness for peace." It has been borne in on them very strongly that with the loss of a million or more of their best men, they are bound to do everything they can to preserve and build up the next generation; that they cannot afford to let it grow up in unsanitary and disagreeable surroundings.

We found in Paris that the city government had since the beginning of the war organized a city planning bureau with broad powers which is planning comprehensively the whole metropolitan area, not only within the city but thru all the surrounding district. In Lyons, we found similar plans being worked out. In London, the architects, engineers and city officials have come together and are working out most extraordinarily comprehensive plans specially for traffic routes for an area of nearly 2,000 square miles around London.

The Planning Commission.

But more striking still, were the plans which they showed us for the replanning of Rheims and some of the other destroyed towns. In France, they have come to realize that they must make a virtue of their necessity and rebuild the destroyed cities along modern, scientific lines, always preserving as far as possible the charm of the past. They have gone further still, and now appreciate the vital need of general scientific planning. They have actually framed a law which has already passed the Senate—the Loi Cornudet—according to which every city, town or village in France, regardless of whether it is in the destroyed area or not, will be forced to lay out all its future developments according to modern city planning principles. Every community will have to have its city planning commission, over which there will be a general commission in each of the 86 departments, and over these in turn, there will be a federal commission, so that all may work along similar lines and so that the whole area of France will be laid out according to one great comprehensive plan.

They are doing these things because they find that they have got to do them to meet the economic competition with other countries which is coming after the war. There must be no waste, and they are providing to eliminate every possibility of it. France is doing all these things at enormous cost, despite the superhuman work of carrying on the war. She is doing it because she finds it necessary to make up for the mistakes of unpreparedness. We in America are remarkably fortunate in having the example of their experience before us. It is comparatively easy for us to plan for these emergencies; be they in aviation, in the transportation of men or supplies, in housing or recreation, or in the working out of general all including plans. In peace times, it is sheer common sense to give our best thought to the planning of our cities. It is imperative to do so now to meet the demands of war.

Keep Up With the Truck

By C. P. Cary.

The reality of war brings home to us the seriousness of our transportation. We have been accustomed in peace times to pay as high as 7 per cent. as a charge for delivering to our homes the food we eat. We did not feel it, this charge being nominal and included in the cost of the purchases. We traveled from our homes in the country to our business in the city on the steam trains, in many instances for less than two cents per passenger mile. This afforded the man of small salary and large family a healthful home for his children in the country.

Recently the Interstate Commerce Commission listened to officials of railways concerning the 15 per cent. increase in freight rates. This was claimed as necessary in order to assure the roads a safe marginal profit which would justify the needed requirements. This advance in rates will not compensate for expenditures necessary to provide new rolling stock and equipment imperative for intensified service necessary now.

Two Hundred Per Cent. Increase in Freight Traffic.

The advance in labor and rolling stock during the past three years exceeds in some cases 100 per cent., and the demands so far exceed production that no one knows to what height this increase will go. Intensified railroad development already has reached the maximum, and increased capital with extension of lines is now necessary. There has been an increase during the past ten years in locomotive tractive power of over 40 per cent., with an equal increase in freight car capacity. During that period trains have increased their tonnage over 70 per cent. Freight traffic has increased in the eastern cities 200 per cent. faster than the population. Still cities everywhere are rapidly spreading, and demands for spur tracks with locomotives and cars are in urgent demand. This

kind of work handicaps the transfer of freight, for the equipment is greatly needed elsewhere.

Transportation is one of the most vital problems confronting the entire world at present. It is demanding the concerted efforts of the best brains to prevent an immediate breaking down of both land and water systems. It requires a stupendous amount of money, materials and skilled labor immediately.

Motor Buses in the West.

In California motor buses have successfully operated at two cents per passenger mile. During the summer of 1916 in Yuma, Ariz., 6-ton motor trucks hauling 6-ton trailers, delivering road material over the desert roads a distance of 13 miles, operated consistently 24 hours out of the 24 hours in the day at a ton-mile cost of $0.051. The writer examined these trucks after 15,000 miles of this kind of service and found them in excellent condition.

California, Arizona and Nevada have of necessity developed the motor truck and motor bus to a point where they successfully bridge the gap left open by inadequate steam and electric railways. Last summer one could ride from Stockton to Sacramento, 53 miles distant, in a comfortable bus, at an average speed of 25 miles an hour for $1.00. A ton of goods could be delivered in San Jose from San Francisco, 50 miles distant, by motor truck, at a less charge than by any other common carrier. Motor stages operate between San Francisco and Los Angeles at the present time, covering nearly 400 miles in the trip, at a charge equaling steam train fare. From San Pedro Harbor to Los Angeles, motor trucks, hauling several trailers, delivered 25 to 75 tons per trip at an operating charge of less than 50 per cent. of the costs of any other transport.

London, Liverpool and Manchester have for years operated lorry trains, consisting of two or more trailers attached to a steam or gasoline tractor.

Highways Should "Stand the Gaff."

We have not as yet discovered the true application of motor vehicles. There is no instrument of transportation available today capable of such immediate and immense possibilties. Yet this great asset to the country is in its swaddling clothes thru lack of intelligent and systematic application. It is not only a lamentable but serious fact that less than one per cent. of business houses using motor delivery are familiar with its value of operation, and this important system is left to the discretion of men incapable of improving or perfecting this branch of the business. In fact, the cheapest grade of labor is used, not only in the operation, but in the disposition of these units.

The government will do much to improve motor truck application for its specific requirements, particularly within the provinces of the military branch. It will not develop the truck as a public utility. This cannot be done until a systematic co-operation has been promoted by the government and a commission appointed of transportation men from the railroads, motor truck interests and men selected from the state highway commissions.

We cannot afford to delay longer such an action. Our highways are our public arteries, which should be used for Intercity, passenger and freight traffic. We should be using now motor truck trains as freight carriers and our freight depots should be open 24 hours daily. Our big business houses should inaugurate a 24-hour-of-the-day service in their freight departments. Intelligent improvement should be made in our highways, bridges and culverts, as well as in the laws governing the use of motor trucks and motor buses as common carriers. Until the government takes such action, the few of us who are striving to bring highway transportation into its own will be only continuing to drive a square peg in a round hole.

WATER WORKS MAINTENANCE AND OPERATION

Installing and Maintaining Water Service Connections in St. Paul

By Garrett O. House, General Superintendent, Bureau of Water, St. Paul, Minn.

On December 31, 1916, the records of the St. Paul water department indicated that 40,072 service connections were in use. Of this number, 34,879 were metered, 4,983 were on flat rates and services laid in advance of paving, and 210 were fire supplies. Of this entire number, 35,000 are ⅝ inch in diameter.

The size of service connections can be controlled by the proper selection of a method for charging for service connections. Four methods are in common practice in the United States:

1. The water works installs the service connection complete from main to building, and considers the expense thereof a part of the distribution system investment.

2. The water department makes the tap in the main, charging the owner of the premises supplied the cost thereof, and authorizing a licensed plumber to install the balance of the service connection under the supervision of the water works at the expense of the owner of the property.

3. The water department installs the service from the main to the property line at the expense of the owner, and authorizes a licensed plumber to complete the service into the building under prescribed rules and regulations relating thereto.

4. The water department makes the entire installation, charging the cost thereof to the property owner.

Methods two and three are the most common, the first and last being used in only a few cities.

How Services Are Paid For

The rules of the St. Paul Bureau of Water provide that the bureau will furnish all of the materials and do all of the work incidental to the installation of the service pipe from the water main to the property line. Method three referred to. While this procedure requires a considerable organization and involves considerable labor and supervision, I believe it is the proper way to install connections, because experience has shown that men engaged in this line of work become, after a reasonable amount of experience, expert, and that the work done by them is better than by the ordinary plumber who has very little experience, and also because the city purchases better materials, and they are more carefully inspected, and also performs the labor for a lower price, all of which results in a benefit to the owner of the premises served, who

is, by virtue of being a citizen, a stockholder in the water works.

In St. Paul, the cost of all labor and materials for service connections from the street main to the property line is paid by the property owner. This procedure is, in my judgment, better than for the water department to make at its own cost the service installation, considering it as a portion of the investment in the water works plant.

The material entering into a service connection less than 3 inches in diameter is of materially shorter life than the underground street mains and is, therefore, less permanent.

It is also a fact that demands for larger service connections than necessarily would be made unless rules and regulations were laid down limiting the size of service connections with reference to the size of building or use which was to be made of the water. When the consumer pays for the service connection, he does not care to make a larger investment than is necessary, and the size of service connection is kept as small as necessary.

The question of maintenance and repairs for this service connection during its reasonable life is also a debatable one.

All Repairs Paid by Owner

At present, in St. Paul, the water department makes all repairs to water service connections at the expense of the owner, the actual cost being charged therefor. In my judgment and in the light of experience in St. Paul, this rule should be changed so as to provide for the maintenance and repairs by the Bureau of Water and at the expense of the Bureau of Water for a period of time representing the reasonable life of the service pipe.

The regulations of the department of public works in St. Paul, who have exclusive jurisdiction over all public streets, provide that no unlicensed person shall make any excavation in the street. If the owner of premises is not permitted by the department of public works to make any excavation in the street and is not permitted by the Bureau of Water to make any repairs to the water service connection, and further, if the Bureau of Water installs the water service connection, the owner has very little to say about it, and, in my judgment, cannot be held responsible for other than natural deterioration of the service pipe, which should be guaranteed to him for a reasonable life.

The repairs which are usually necessary to be made to water service connections of the smaller sizes when installed, either of lead or galvanized iron pipe, are due to imperfect workmanship or materials, or to settlements near the pipe on account of other excavations, or to freezing or electrolysis, to none of which can the owner be held responsible.

Mitigation of Electrolysis

One of the principal causes of deterioration in many cities, with both water mains and service pipes, is that due to electrolytic action caused by stray electric currents passing from the service pipe into the surrounding soil.

The source of these stray electric currents is usually from the rails of an electric railway system.

Electric current used for propelling street cars is usually direct current generated at about 500 volts. It is conducted along the trolley wires, down the trolley pole, into the motor, and from thence is conducted to the rails, and from thence back to the generator in the generating station.

On account of the numerous joints in the street railway rails, and imperfect bonding around them, the return current often finds a path of less resistance through the earth and jumps from the rails into the earth and on to the pipes of a water works which are laid in the ground; and as they offer a path of still less resistance than the earth, the return current follows along them to the generating station, instead of over the rails or the earth. If the water pipes should offer no resistance, the return current flowing on them would do no damage, but at various points considerable resistance is offered and the current jumps from the water pipe into the ground again. At these points electrolytic action is set up, causing deterioration of either lead or iron pipe, the rapidity depending upon the amount of current flowing.

The most successful means now employed to eliminate electrolysis is by the installation of insulated copper cables, connected at frequent intervals with the rails and finally terminating at the generator in the generating station.

This means is effective because a path of less resistance than over the rails, the ground, or the underground water piping system is made, so that the return current has no desire to leave.

The worst feature of electrolytic action to a water works company is that it is progressive and cannot be detected until deterioration has progressed so far as to cause the pipe to leak, and it is not at all certain that because no leaks are discovered that damage from this source is not being caused.

Another cause of trouble which we all experience in this northwest country is that of freezing service connections. Our experience in St. Paul in this respect is particularly interesting.

Thawing Out Frozen Services

Previous to last winter, frozen water service connections were a source of anxiety to the department. When complaint was made that a service connection was frozen, no one could, with certainty, in most cases, determine where in its length the frozen portion could be found. It was first necessary to excavate to expose the corporation cock and gooseneck as the most likely point of trouble, disconnect the union and observe. If no water came, or ice was seen, it was evidence we had made a poor guess, and that another excavation was necessary. When the trouble was located it was removed by the application of heat. This procedure would occupy from two days' to two weeks' time, during which the consumer was deprived of a water supply and was usually bitter in his denunciation of the water department.

After a very careful investigation, the writer prepared specifications for a gas engine electric generator set to be mounted on a motor truck trailer. The engine is a 4-cycle gas engine designed to run at 1,000 revolutions per minute at full load. It is direct connected by a leather link, flexible coupling to a generator.

The generator is of the direct current type, having a rating of 20 kilowatts, producing 500 amperes at 40 volts. For the control of the generator a switchboard is installed, upon which are mounted indicating electrical instruments together with a regulating rheostat, designed to regulate the voltage generated by the generator between zero and 40 volts. In addition to the engine, generator and switchboard, there is also a reel installed on the truck, mounted on a steel frame. This reel carries 500 linear feet of 300,000 C. M. extra flexible insulated copper cable, in 100-foot lengths.

The trailer is a Troy trailer of the reversible motor truck type, having a capacity of 1½ tons. The generating equipment and reel are secured to a steel frame, so that the entire equipment as a unit can be removed from the trailer in the spring and permit the trailer to be used during the summer season for any other purpose.

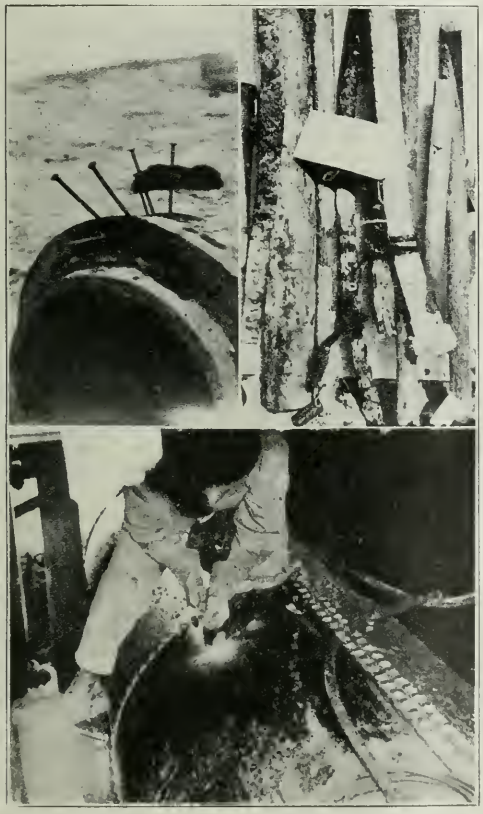
Special Plant Thaws Pipe in Few Minutes

The procedure in thawing out a frozen service pipe is about as follows:

The trailer is attached to a motor truck and hauled to the location of the frozen service pipe, a sufficient amount of cable is unreeled to reach from the generating apparatus to the basement of the house, and also another line to reach from the generator to the nearest fire hydrant. One end of the first cable is attached to the positive terminal of the main switch, and the other end attached to the service pipe on the

street side of the meter in the meter box. The second cable is attached to the negative terminal of the main switch and to the revolving nut on the top of the nearest fire hydrant. The gas engine is then started and brought up to speed with the main switch open. The main switch is then thrown in, and, by means of the rheostat, the generator is regulated to give about 400 amperes at zero to 5 volts. After running at this point of regulation for about a minute, the voltage is raised to about 75 per cent. of the capacity of the machine, and at this rate it is seldom necessary to continue furnishing current for more than three minutes. Most service connections are relieved of the ice obstruction in two minutes. In a few instances with large pipe and serious freezing, it has taken fifteen minutes to remove the obstruction.

During the winter of 1916, sixty-one connections were thawed out, and thus far in 1917 we have used the machine in seventy cases. It has operated with perfect satisfaction, and we have never yet found a case where relief could not be given.



EFFECTS OF ELECTROLYTIC ACTION ON SEATTLE WATER PIPES. LOWER VIEW SHOWS MAIN BEING CUT FOR REPAIR.

In the winter of 1916, which was the first season service was given by the machine, we attempted to charge for the actual cost of the use of the machine, including labor, supplies, interest and depreciation. It became evident that this method was not fair, because the owner of property a long distance from the storeyard of the water department was compelled to pay considerably more for the service than one who lived within a few blocks, so that this year we are charging a flat rate of $5 per service, which is payable in advance.

With this machine in successful operation, we can now assure a consumer of water, who is so unfortunate as to have a frozen service connection, that relief can be given in a few hours, which is real service and carries with it much more than its intrinsic value.

Seattle Electrolysis Problem

By L. B. Youngs, Superintendent Water Department, City of Seattle

Grounded current from the power system of the Puget Sound Traction, Light and Power Company, which operates the street car lines in Seattle, is responsible for an incalculable loss in ruined water pipes, the destructive effects having extended over a considerable period of years. This has for a long time been a perpetual source of expense to the department. Bills have been presented to the company regularly for the cost of these repairs, but thus far the company has refused to acknowledge any liability.

Investigation Shows Damage

A thoro investigation into the cause of this destruction of pipes and services was made during the years 1911 and 1912, and the evidence placed in the hands of the corporation counsel. As an example of this destructive action of the electric current on the pipes, I incorporate in this article a few pictures taken at points where the pipes had to be renewed.

Few people realize how rapidly an electric current will eat out a pipe. On Melrose avenue the banding on 4,000 ft. of 18-in. wood stave pipe was eaten out in seven years. The 42-in. steel pipe on Twelfth avenue, south of Jefferson street, was badly pitted and in some cases eaten entirely thru. Along one seam lengthwise of the pipe for a distance of 6 ft. the metal was three-fourths gone. The pipe had been in the ground only ten years. The holes in this pipe had to be plugged with rivets and some of it replaced with new pipe. The destruction is most rapid, however, in the case of small service pipes. Some of these have been eaten out in three months. At 1221 East Jefferson street a service pipe was replaced on August 7, 1909, again on March 30, 1910, July 3, 1910, and October 17, 1911.

More than Ten Thousand Dollars Damage

Up to the date of the last water department report the repairs on mains and services that have been made necessary on account of destruction by electrolysis amount to nearly $10,000. Of course, this does not take into account the constant disintegration of the pipe which is going on and which reveals itself only when the pipe fails to convey water and breaks into leaks.

Kansas Law Requires Oil-Free Water

As the result of considerable trouble with drinking water caused by discharges from oil and gas wells, the Kansas Legislature has passed a bill making it an offense to permit any discharge that will render city water supply "deleterious for use for domestic purposes." The fine for violation of this statute has been fixed at from $25 to $100 per day for each day the oil causes damage. Prosecution must begin not more than ninety days from date of the offense. That such legislation was a necessity may be seen from an analysis recently made of water from the Walnut river, near Douglas, Kans. This showed a solid content of 2,736 parts per million, the principal parts of which were sulphates and chlorides.

Advance Information on Big Jobs

Information for Bidders on the Shandaken Tunnel Contract

Bids will be received by the Board of Water Supply of the city of New York, at its offices, twenty-second floor, Municipal building, Park Row, Centre and Chambers streets, New York City, until 11 a. m., on Tuesday, September 11, 1917, for a contract for the construction of the Shandaken tunnel. The tunnel is part of the Schoharie watershed development for the New York City water supply, is 18 miles long, and will carry water from the Schoharie reservoir to Esopus creek. The finished tunnel will be 11 ft. 6 in. high by 10 ft. 3 in. wide, lined with concrete masonry, and will have 8 shafts.

The tunnel has been divided into two portions, to be known as the north and south portions, so that bids may be submitted for either portion or for the entire tunnel.

At the above place and time the bids will be publicly opened and read. Pamphlets containing information for bidders and contract drawings can be obtained at the above address, at the office of the secretary, by depositing the sum of $20 in cash or its equivalent for each set. For further particulars apply to the office of the principal assistant engineer at the above address.

General Features of the Shandaken Tunnel

Four general lines for the tunnel were considered during the engineering studies preliminary to final location and design: Two lines beginning east of and two lines west of the Schoharie creek, the difference in the two of each set being in their relative shaft locations. The four lines joined on the west side of the Schoharie creek at a point west of Lexington, from which point they were common, entering the Esopus valley near Shandaken. The two easterly lines were abandoned, as they were more costly.

The location finally adopted has the headworks on the westerly bank of the Schoharie creek, on the Delaware-Schoharie county line, and enters the Esopus valley near Allaben.

The general features of the Shandaken tunnel are as follows:

Length, miles	18
Capacity, gallons daily	600,000,000
Elevation of intake	1,050
Elevation of outlet	970
Slope between shafts 1 and 7 (equals 4.4 ft. per mile, or 1 in. per 100 ft.)	0.000834
Height	11 ft. 6 in.
Width	10 ft. 3 in.
Number of shafts	Intake shaft and 7 others

Between intake shaft and shaft 1 is a pressure tunnel.

Maximum depth of shaft, 629 ft. at shaft 5.

Minimum depth of shaft, 319 ft. at shaft 2 (not including intake shaft, which is 260 ft.)

Total depth of shafts, 3,315 ft.

Greatest depth of tunnel below surface, 2,215 ft. under top of mountain just east of Deep Notch.

Specific and General Information to Bidders

The work contemplated in the contract is the construction of the Shandaken tunnel in the towns of Gilboa, Schoharie county; Roxbury, Delaware county; Prattsville and Lexington, Greene county, and Shandaken, Ulster county, New York. The tunnel is approximately 18 miles in length and is a part of the Schoharie watershed development for the New York City water supply. It will carry water from the Schoharie reservoir, which will be formed by constructing a dam across the Schoharie creek valley at Gilboa to the Esopus creek, at a point near Allaben. From this outlet the water will follow in the natural bed of Esopus creek to the Ashokan reservoir.

The main tunnel will be substantially of a horseshoe shape, 11 ft. 6 in. high by 10 ft. 3 in. wide, lined with concrete masonry, and in residual spaces above the masonry lining filled with grout. The tunnel will have eight shafts; the most northerly one will have at its head the intake chamber and the others will be decked over and covered by small superstructures. At the southerly end there will be a short stretch of aqueduct constructed in open cut and a short walled and paved outlet channel connecting the tunnel with Esopus creek.

Access to the Work

Grand Gorge station, on the Ulster & Delaware Railroad, is about 5 miles distant from the two northerly shafts, and Shandaken station, on the same railroad, is about a half mile from the southerly end of the tunnel. The shafts are, in general, located near a main highway going over the mountain from Shandaken to Prattsville. In order to afford better and more ready access to the most northerly or intake shaft, the grading of a portion of a new highway, which will be made necessary by the Schoharie reservoir, is included in the contract with a view to its use in constructing the tunnel. Permanent access roads are also to be provided to each shaft from adjacent highways, and these may be built early and used for construction purposes.

Power for Construction Purposes

Under suitable conditions use will be given of Catskill aqueduct and reservoir lands, as well as lands of the Shandaken tunnel, for a temporary power transmission line from the lines or plant of an existing power company or from a power plant to be established by the contractor. A study of methods of securing power for constructing the tunnel has been made, and this information is open to examination by bidders at the office of the engineer.

Geographic and Topographic Features

The principal geographic features near the site of the work are shown on the locality map of the contract drawings and complete topography of the region may be found on the Gilboa, Hobart, Margaretville and Phoenicia quadrangles of the United States Geological Survey.

For the convenience of intending bidders, the line of the proposed tunnel has been marked upon the ground with sufficient clearness to enable a person to find it readily. Conspicuous signs have been placed at the shaft sites.

Blasting a Canal

The canal of the Miles City, Mont., Canal and Irrigating Co. was washed out by a flood on the Tongue river and the face of the bluff had to be removed to give place for the new location of the canal. H. E. Fearnall, engineer for the company, did the job with DuPont blasting powder and red cross dynamite. He bored a series of holes horizontally 8 feet into the bluff, large enough to slip in a 25-lb. can of powder with three sticks of dynamite in it. Holes 3½ feet apart for about 100 feet in length are used in one blast. The blasts were used down to the bottom of the canal.

How the Contractors are Bidding

Recent Bids on Pipe Sewers and Sewage Treatment Plant in Illinois Towns

Engineers are requested to send the editor tabulations of contractors' bids received on all sorts of public works construction jobs. The data given should not be fragmentary, but should approach completeness as the desirable limit.

While the title of this section is considered self-defining, let it be said by way of amplification that enough explanatory matter should accompany the tabulations of bids so that the reader can interpret the prices given and form a clear idea of what the figures signify. The ideal form of presentation is a short story giving a digest of the specifications under which the bids were received and describing local conditions which influenced the making up of the bidding prices. With all the information at his finger tips, these data can be compiled by the engineer in surprisingly short time.

It is desired that all parts of the country be represented in this department and all branches of public works construction covered. The contractor is a migratory bird and is attracted to localities where high bidding prices prevail. Thru this department engineers can check up on the bids they are receiving in comparison with those offered in other places.

TABLE I—BIDS ON PALESTINE PIPE SEWERS.

Quantities	Engineer's Estimate		Embankment Co. Joliet, Ill.		A. House & Co. St. Louis, Mo.	
3,130 ft. 12-in. tile sewer avg. cut 9.0 ft.	$1.00	$3,130.00	$1.04	$3,047.20	$1.15	$3,599.50
3,900 ft. 10-in. tile sewer avg. cut 8.3 ft.	.75	2,925.00	.81	3,159.00	.90	3,510.00
15,450 ft. 8-in. tile sewer avg. cut 7.0 ft.	.55	8,497.50	.63	9,733.50	.65	10,042.50
73 brick manholes	27.50	2,007.50	44.00	3,212.00	40.00	3,504.00
10 flush tanks	75.00	750.00	73.00	730.00	75.00	750.00
Total for sewer sy'tm.		$17,310.00		$19,881.70		$21,406.00

Sewerage Bids at Palestine, Ill.

Table I gives the engineer's cost estimate and bids by two construction companies on a system of pipe sewers for the town of Palestine, Ill. The bids were received on August 1 with the understanding that construction work was to begin on or before August 15. The work presented no unusual features Trenches were all dug to full depth in dry sand.

The brick manholes mentioned in Table I are circular in section, 3 ft. in diameter. They are of two rings of brick, and average 7½ ft. deep. The flush tanks are of brick construction, 2 rings, 4 ft. in diameter and 5 ft. deep. They are equipped with 5-in. Miller siphons made by the Pacific Flush Tank Company, of Chicago. All the Palestine work was awarded to the Embankment Company, of Joliet, Ill.

Table II gives the bids on the Palestine sewage treatment plant. The drop manhole mentioned is 7½ ft. deep; the 200 ft. of 12-in. sewer first mentioned is in an 8-ft. cut and the other 200 ft. of 12-in. pipe is in 4-ft. cut. The concrete diversion chamber measures 4x8x10 ft., and the settling tank 15x 40x12 ft. The 200 ft. of 10-in. sewer is in 3-ft. cut. Besides the itemized bid on the sewage plant given in Table II there was a lump sum bid of $9,000 by Sell & Kollar, of Pana, Ill.

Bids on the Warsaw, Ill., Sewers

Table III schedules the bids made on the Warsaw, Ill., sewer system. These bids were received on June 26 and work has been in progress for over a month. All trenches were in clay. The pile supports mentioned were at the outlet. The average cuts on the various lines were as follows: 15-in., 7.2 ft.; 12-in., 12.9 ft.; 10-in., 8.6 ft.; 8-in., 8.5 ft.; and 6-in., 7.7 ft. The Warsaw contract was awarded to Harness Bros., South Ottumwa, Ia.

On all the work here mentioned W. S. Shields, Hartford building, Chicago, was consulting engineer.

TABLE II—BIDS ON PALESTINE SEWAGE TREATMENT PLANT.

Quantities	Engineer's Estimate		Embankment Co. Joliet, Ill.	
1 drop manhole	$ 27.50	$ 27.50	$ 55.00	$ 55.00
200 ft. 12-tile sewer	1.00	200.00	1.25	250.00
1 concrete diversion chamber with equipment	150.00	150.00		350.00
1 combined settling tank and dosing chamber	3,650.00	3,650.00		3,990.00
4 sand filters 40 ft. x 60 ft.				
4 sand filters 40x60x2 ft. concrete curb and drain.	525.00	2,100.00	900.00	3,600.00
200 ft. 12-in. outlet sewer plant to outlet ditch	1.00	200.00	1.00	200.00
200 ft. 10-in. sewer pipe connecting filters	.80	160.00	.70	140.00
205 yds. excav. in straightening ditch	.50	102.00	.50	102.50
Total		$6,590.00		$8,687.50

Good Results With Convict Labor

Municipal contractors in Omaha, Neb., have secured excellent results by the use of convict labor supplied by the city to make up for the deficiency in free laborers. A rate of 25 cents per hour per man was paid to the city, of which amount 10 cents went into the benefit fund which each convict receives at the expiration of his term. This labor is only supplied in such cases as cannot be taken care of by free labor.

Towns Pay State Road Tax

In a bill passed by the Rhode Island State Legislature provision was made for payment of special tax by cities and towns, this money to be used for building and improving highway. The new tax, added to the moneys now coming from automobile license fees and Federal aid, brings the total fund available for 1917 work to approximately $400,000.

TABLE III—BIDS ON WARSAW, ILL., PIPE SEWER SYSTEM.

Quantities	Engineer's Estimate		Harness Bros. So. Ottumwa, Ia.		Monie & Dunbar St. Louis, Mo.		U. B. Waters & Sons St. Louis, Mo.		Eiff & Simons Quincy, Ill.	
125 ft. of 15-in. wrought iron outlet pipe	$ 3.00	$ 375.00	$ 3.50	$ 437.50	$ 3.80	$ 475.00	$ 5.00	$ 625.00	$ 4.00	$ 500.00
Pipe supports		125.00		150.00		150.00		200.00		150.00
670 ft. of 15-in.	1.20	804.00	.935	626.45	1.40	938.00	1.25	837.50	1.40	938.00
3,280 ft. of 12-in.	1.10	3,608.00	.88	2,886.40	1.20	3,936.00	1.20	3,936.00	1.20	3,936.00
2,600 ft. of 10-in.	.85	2,210.00	.735	1,911.00	.85	2,210.00	.90	2,340.00	.85	2,210.00
14,590 ft. of 8-in.	.65	9,483.50	.655	9,556.45	.65	9,483.50	.60	8,754.00	.65	9,483.50
4,650 ft. of 6-in.	.50	2,325.00	.50	2,325.00	.50	2,325.00	.45	2,092.50	.50	2,325.00
90 brick manholes	30.00	2,700.00	40.00	3,600.00	40.00	3,600.00	50.00	4,500.00	45.00	4,050.00
Total		21,630.50		21,492.80		23,117.50		23,285.00		23,592.50

Pavement Cleaning and Maintenance

Present Practice and Regulations Pertaining to Pavement Openings

By Arthur H. Blanchard, Consulting Highway Engineer, New York City, N. Y.

Pavement openings are primarily due to the installation, extension and repair of such subsurface structures as sewers, street railway track accessories, pneumatic tubes for mail services, subways, and pipe for water, steam, gas, telephone, telegraph and electric light wires. The magnitude of the pavement opening problem is readily appreciated when it is noted that in one year the city of Boston issued 15,696 permits covering a total combined length of openings of 1,014,807 feet, or about 193 miles.

The present unsatisfactory status of pavement openings in many municipalities of the United States is due to one or more of the following contributing causes: (1) Lack of centralized administration; (2) inadequate supervision by highway departments; (3) utilization of inefficient organizations and methods for back-filling trenches, making temporary surface repairs, and final replacement of artificial foundations and pavements.

Administration and Organization.

Present practice in administration and organization governing pavement openings varies from absolutely no control by a city official to a thoroly organized administration, such as is found in the cities of Cincinnati and Philadelphia, for example. In Cincinnati it is unlawful for any person, firm, corporation or city department, other than the street and sewer repair department of the department of public service, to make openings unless a permit is obtained. Philadelphia, with its perfected organization of experienced engineers and inspectors, under the permit division of the bureau of highways, has an efficient workable plan of control which is worthy of investigation and duplication.

Lack of knowledge of subsurface structures in the majority of municipalities is recognized by municipal authorities. Recently endeavors have been made in several municipalities to remedy this condition. The practice of the boro of Brooklyn of New York City, Philadelphia and Houston, Texas, are cited as examples. In Houston all persons, firms or corporations owning pipes, etc., were required to file with the city, within ninety days after the passage of the ordinance, a map on a scale of 200 feet to one inch, which showed the exact location, size and description of its mains, laterals and other subsurface structures, and furthermore, in each year within fifteen days after January 1 a corrected map or set of maps must be filed.

In many cities it has become the practice to post notices on highways to be paved or repaved and to forward such notices to all property owners residing on streets to be improved and to persons, corporations and city departments who control subsurface structures on such streets. As an example of such notices, that issued by the city of Baltimore is herewith quoted:

"You are hereby notified that the street bounding this property is to be paved with improved pavement and that the work will commence shortly after six weeks subsequent to the date of this notice. All necessary underground construction for installing or repairing gas, water, electric and other subsurface structures must be done before the street is paved. No permits to cut trenches or to disturb the pavement will be issued. Notice to the above effect has been given by public advertising."

The ordinance of the city of Cincinnati states that no permits will be granted within a period of three years after the construction of pavements except on account of emergencies.

Permits and Payments for Reconstruction.

Practically all municipalities with over 50,000 inhabitants require some form of permit of a person or corporation desiring to make an opening in a pavement. In many cases, however, the securing of a permit is a mere formality, as in the case of one municipality of 250,000 inhabitants, whose ordinance only requires for the permit a payment of $2.00 and notice in writing to the commissioner of public works that an opening is to be made. On the other hand, several municipalities require compliance with definite and adequate regulations. As an example, the following excerpts from the ordinances of Pittsburg are mentioned: The application for a permit must contain a complete detailed description covering location, size of openings, nature of substructures, etc.; a bond of $500 for one opening and $2,000 for an indefinite number of openings must be filed; a deposit to cover the cost of repaving must be made.

The amount of deposit required with a permit varies to a remarkable degree. Some municipalities have adopted a logical basis of charging the cost of repaving plus a certain percentage for inspection and other overhead charges. In the case of the city of Seattle, where all repairs, after the trench is opened, are made by department men under the direction of the superintendent of streets, a deposit is required based on the following rates: Two dollars and fifty cents for each cubic yard of earth filling; $5.00 for the first square yard of pavement; $3.00 per square yard for each additional square yard broken up. Upon the basis of a signed statement by the superintendent of streets, the city treasurer pays back unexpended part of deposit, retaining 10 per cent. of actual cost for overhead charges; a utility company may, however, deposit $500 for cost of repairing street openings, renewing same as required.

It should be noted that many cities have adopted a schedule of rates of repaving, dependent upon the kind of artificial foundation, type of pavement and the yardage of opening. For example, Schenectady, N. Y., makes the following charges for artificial foundations and pavements: Asphalt, brick or granite block, $10.00 for the first square yard and $3.00 for each yard thereafter; for macadam, $3.00 for the first yard and $1.00 for each yard thereafter.

In this connection it has been recommended, in the case of Richmond, Va., that the ultimate cost of installation of lateral connections by public utility companies would be materially reduced if all lateral connections, the usefulness of which could be predicted, were made prior to the time when the street was paved or just before a street was paved.

Back-filling, Artificial Foundations and Reparing.

Great variation is found in the practice of American municipalities with reference to making repairs of openings by city departments, contractors or public utility companies. In some cases all repaving work is done by the permittee. In Albany, for example, public service corporations open, backfill and repave; while in other instances, back-filling and repaving are done under the direction of the commissioner of

public works. Many municipalities allow the permittee to open and back-fill, artificial foundations and pavements being constructed by city departments. In a few instances, as in the case of Seattle, the city does all the work with experienced men, the result being that openings are repaired in an efficient manner and very little trouble results thereafter. It is well to note that the public utility companies of Seattle appreciate having the work done by experienced employes of the municipality, thus relieving them of responsibility in connection with repairs.

Inefficient control and methods of back-filling are the cause of a very large percentage of the troubles arising from pavement openings. Even with the accumulated knowledge and experience now at hand, many municipalities today allow back-filling to be made by the inefficient method of merely shoveling in as much material as the trench will hold. Advanced methods of back-filling are, however, in use in many municipalities, where it is required that all material excavated, except rock, shall be placed in the excavation, thoroly tamped in layers of from 3 to 6 inches, or flushed if the materials and other conditions are suitable for this method of compaction.

Houston, Texas, goes a step farther and requires that trenches under pavements shall be refilled with well-rammed gravel, broken stone or brickbats, or refilled with tamped earth and covered with a reinforced concrete (1:2:4) slab, which must project 12 inches on each side of the trench and have a depth of 10½ inches for a 2-foot opening, increasing to 15 inches for a 6-foot opening.

In several municipalities, it is required that the cement-concrete foundation shall be cut back for 6 inches on all sides of the opening and be replaced by new cement-concrete, thus forming a slab to bridge over the trench.

Conclusions.

Based on observations of practice in many municipalities thruout America and Europe, the following conclusions are submitted as applicable to general conditions found in municipalities thruout the United States.

Administration and Organization.

Pavement openings should be absolutely under the control of the chief of the bureau of highways; all persons, corporations and other city departments being required to secure permits from the highway department prior to making openings in pavements, except where emergency conditions require such openings to be made in the interests of public health and welfare.

Notices should be advertised, posted and sent to all interested parties, giving ample warning in cases where streets are to be paved or repaved and containing the provision that charges to the permittee will cover cost of back-filling, but not artificial foundations and pavements. The practice of not allowing pavement openings to be made within a certain period after a payment is laid is believed not to be in the interest of public progress and is unnecessary if the notice advocated is given and efficient methods of control, back-filling and repaving are adopted.

Plans of subsurface structures on all streets should be compiled and permits should be granted only after accurate and detailed information has been filed pertaining to all details of substructures in connection with the given pavement opening.

Deposits should be required covering cost of back-filling, reconstructing artificial foundations and repaving, which should be based on a schedule of rates dependent upon the character of back-filling, type of artificial foundation, kind of pavement and yardage of the several items. An adequate percentage should be added to the cost of the above items to cover supervision and other overhead charges.

After a permit has been granted, excavation should be made by the permittee, and back-filling and repaving done under the supervision of engineers of the highway department and by a flying squadron of experienced men in the employ of the department.

Back-filling and Artificial Foundations.

All material excavated, except rock, should be replaced in the trench and, in the process of back-filling, the material should be thoroly compacted by hand or mechanical tampers, or with the aid of water used sparingly, dependent upon the character of soil and kind of pipes. The wise saying of an old road foreman, that two tampers are required for every shoveler in order to secure satisfactory compaction, should be borne in mind in organizing the flying squadron of experienced laborers.

Except in the case of water-bound gravel and broken stone roads, cement-concrete foundations over trenches should be constructed, and such foundations should extend 6 inches beyond each side of the trench and have a depth of not less than 8 inches. If the methods outlined above are adopted, it is not necessary to postpone repaving, provided climatic conditions are satisfactory for such work.

If temporary repaving is, for any reason, necessary, it is recommended that the back-filling, as above outlined, be carried to the elevation of the top of the artificial foundation and that such materials as small stone blocks, paving bricks laid flat, asphalt block seconds, or hot or cold bituminous concrete should be used for a temporary wearing course.

Repaving.

In the process of repaving, it is recommended that the old pavement be cut back 3 inches on each side of the new cement-concrete foundation. The adoption of this plan will eliminate planes of weakness and will insure the practicability of making an efficient bond with the old pavement.

Sidewalks.

The ground beneath sidewalks in municipalities should be kept clear of vaults and other accessories of buildings. The space under sidewalks should be reserved for the possible future installation of pipe systems which would relieve present congestion of subsurface structures in the carriageway and reduce the number of openings made in pavements.

Maintaining New York Roads

A large part of the roads of New York have been maintained by patrolmen, each in charge of four to seven miles of road. There has been some question whether this method of maintenance was as satisfactory and economical as that of allowing the road to become somewhat worn and then restoring it by the labor of a gang of men. During 1916 the relative merits of the two systems were tested under the direction of Fred W. Sarr, second deputy highway commissioner, who found that the gang operated with greater efficiency provided it had work enough to keep it busy. But such efficiency in repairs was offset in some degree by the relative convenience to the traveling public of the two systems. The patrolman keeps the road in good condition all the time, by applying practically the old axiom that "a stitch in time saves nine." If he is not employed the road falls into the condition when nine stitches must be taken to restore it, which means that there will be nine ruts or holes for the traveler to jolt over before the surface is made true again, instead of merely a single little rut or depression. Consequently, while the patrolman may be said truly to maintain the road, the gang does not actually maintain it, but rather repairs it. When the road is surfaced with first-class concrete or brick, however, the experience in New York shows that the maintenance is best done by gangs, for the effect of traffic on such roads is different from the effect on water-bound macadam and gravel.

Sewer Design and Construction

Designing Inverted Sewer Siphons

By Joseph L. Hunt, Assistant Division Engineer, Public Service Commission, First District, New York City.

Altho the so-called inverted siphon has been used for a number of years in New York City, it seems that but little literature concerning this type of sewer has been available. The writer has been in direct touch with the work of constructing these sewers and is outlining below the principal features in connection with them.

Inverted Siphon Misnamed

The inverted siphon is misnamed, because it is not a siphon in the true sense of the word, but is simply a sewer which runs under pressure, due to its being depressed under some obstacle in its path, and is similar in its operation to a running trap in common use on all house drains. A true siphon is an upward deviation or bend over and above the hydraulic gradient in a pipe or conduit thru which a liquid is forced due to atmospheric pressure. The only point of similarity between an inverted siphon and a true siphon is that the outlet must be lower than the inlet. In true siphons air and gases are liable to collect at the summit, thereby destroying the action of the siphon, and for continuous successful operation require the installation of some mechanical device to free this air of gases, on account of which they are prohibitive for practical sewer purposes.

A number of true sewer siphons have been constructed in Europe, notably in Breslau and Potsdam, in Germany, and one over the St. Martin canal, in Paris, and are operating successfully, but they will never come into general use, owing to their unreliability and necessary constant attention and maintenance.

Elements of Inverted Siphon

An inverted siphon consists essentially of pairs of vertical or inclined pipes, with a horizontal or graded pipe or conduit passing under the obstruction, joining their lower extremities. The vertical pipes of the inverted siphons commonly constructed in the past were usually large enough for a man to enter, with a sump at the bottom for the collection of heavy material, which otherwise would clog the pipes. Where inclined pipes were used special manholes were sometimes built at the lower bends to facilitate cleaning.

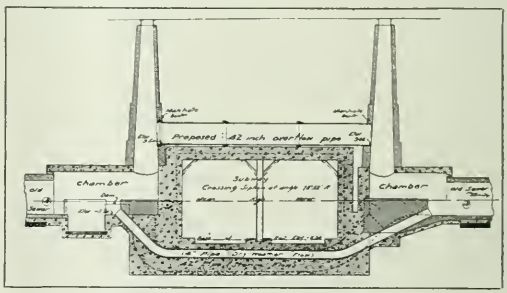
Owing to the number of inverted siphons it has been necessary to construct in connection with the subways, a careful study has been made of this type of sewer, and their operation has been closely watched to reveal their defects, in consequence of which improvements have been made from time to time, with the result that the inverted siphons which are now being constructed are the best that this study and experience can produce.

The type of siphon adopted by the Public Service Commission consists of separate pipes for the dry-weather and storm flow, the reason for which the writer will explain later.

First One Built in 1900

In connection with the construction of the first subway in 1900 a large trunk sewer was intercepted by the structure at 149th street and Railroad avenue, in the Bronx. One of two things had to be done—either the subway depressed to pass under the sewer, or the sewer depressed under the subway. The former proposition would greatly have increased the cost of subway work in this location, owing to the increased depth of excavation below mean high water for a considerable length, and it was therefore decided to depress the sewer. But this was not to be easily done. The invert of the sewer is 2.2 ft. below mean high water, and to carry it under the subway it would have to be lowered at least 10 ft., which is too low for a gravity outlet. A pumping station was considered, but this meant, in addition to the initial cost, a fund for maintenance, repairs and replacements, and the city would not be saddled with this burden, which left as the only solution the construction of an inverted siphon.

Very little was known about the inverted siphon at the time, and grave doubts were expressed about its feasibility in a built-up section of the city where a possible and probable stoppage of the flow would cause untold damage.



INVERTED SIPHON AT 149TH STREET AND RAILROAD AVENUE, THE BRONX.

But in spite of threatened failure, the Public Service Commission's sewer engineers decided to give it a trial, believing that if the pipes of proper size were used so as to maintain a cleansing velocity the objectionable feature would be overcome. In this connection it is well known to all that the dry-weather flow in sewers is very small in comparison with the storm flow, and moreover, it is this flow which has to be considered for the greater period of time, and it is this fact which prompted the idea for the different sizes, and the 149th street siphon is, the writer believes, the first of its type to be constructed.

How Sizes Were Determined

The writer is going to explain in a general way how the sizes of the pipes are determined and also some of the other essential features of their design. The principle of the inverted siphon is that simple one in elementary physics of water seeking its level. But simple as is the principle, the design for successful operation is somewhat complicated due to details to prevent clogging and facilitate cleaning.

To get the size of the small or dry-weather pipe the drainage area is measured on a city sewer map drawn to the scale of 300 feet to the inch by means of a planimeter. The estimated population of this area is then obtained from the census records. In a built-up section this varies from 100 to 500 persons per acre; the water consumption for this area is also obtained from the Department of Water Supply, Gas and Electricity records; this is found to vary from 50 to 120 gallons per capita. It is this water, or what is known as spent water,

which constitutes the dry-weather flow. A generous allowance is made for infiltration and for the future growth of the section, and from these figurese the number of cubic feet per second per acre are compnted. Having this quantity and assuming a minimum of say 5 ft. per second, there is obtained by substitution in the simple hydraulic equation, Q=AV, the value of A, or the area of cross-section of the pipe required. The nearest commercial size to this area is used.

By actual measurements in the sewer at 149th street, and by means of the calculations mentioned above, it was found that a 14-in. pipe running full would take care of the dry-weather flow and two 42-in. pipes would take care of the storm water.

First Sewer Without Defect

After this inverted siphon had been in use for about seven years, during which time it was under the control of the city sewer department, an investigation was made to determine what trouble it had caused, what it had cost to maintain and what defects, if any, could be remedied in future construction. About this time a number of similar sewer conditions had arisen in connection with the Fourth avenue subway in Brooklyn, and the sewer authorities of that boro were still opposed to inverted siphons.

Much to the satisfaction of the Public Service Commission, it was found that this inverted siphon in the Bronx had not caused the least trouble or annoyance and had not been cleaned in the entire seven years of its operation, which was very encouraging to the chief engineer of the commission, and he authorized the engineers to proceed with the design and construction of six additional inverted siphons on the Brooklyn work. In connection with the investigation of the 149th street siphon a number of observations and measurements were taken to determine the actual velocities thru the pipes at different times and the effect of the tides on these velocities. One of the storm pipes was also pumped out and examined, and it was found that, with the exception of a few paving blocks which in some way got into the sewer, the pipe was practically clean.

No Sumps Used

The engineers engaged on this investigation recommended the abandoning of the sump in the up-stream chamber as being unnecessary. These sumps fill up in a short time and then fail to serve their purpose in catching heavy objects, such as bricks and paving blocks, which find their way into sewers. The investigators also recommended that the dam in front of the storm pipes in the up-stream chamber should be raised a little higher on account of the tides and that a similar dam be constructed in the down-stream chamber to keep the sanitary flow out of the storm pipes, as this caused a thick scum to form on the surface of the water standing in the storm pipe between storms, which, thru septic action, gave off foul odors.

These recommendations were adopted in connection with the Brooklyn siphons and new features were added for cleaning the dry-weather pipes and in the construction of the chambers. These features include a clean-out manhole at one of the lower bends of the dry-weather pipe, where a short special split pipe is located, with the upper half removable for cleaning in case of necessity. In these inverted siphons the chambers are simplified and all changes in direction are made with easy bends and curves where possible to eliminate all unnecessary losses of head.

Screens Not Practicable

During the construction of these inverted siphons a suggestion was made to place a screen of bars in the sewer at the approach to the siphon to keep out large floating materials. To test the practicability of this suggestion a temporary wooden screen was set up in a 5-ft. 9-in. by 3-ft. 10-in. egg-shaped sewer leading to one of the Brooklyn siphons. This screen consisted of 1-in. by 1-in. vertical strips spaced 8 inches center to center, to which were nailed four horizontal strips 6 inches apart, thus making the opening 6 inches by 8 inches. The screen was set vertically in the sewer by wedging it between the arch and invert, and was left there for nearly two days, when it was removed to be photographed. It was completely covered for the depth of the flow with rags, paper, twine, wood and other debris, effectively blocking the flow, and showing conclusively that any such device would form a dam in a very short time. Mechanically rotated screens, such as are used in sewage purification plans, would serve the purpose, but could not be used owing to the cost of maintenance.

Siphons Reduce Cost

After the construction of these Brooklyn siphons, which were completed during the year 1911, the next similar work was met in connection with the Broadway-Lexington avenue subway. The successful and uninterrupted operation of all the siphons constructed in the past prompted the engineers of the commission to become bolder in their undertakings and more confident in their design. This was evidenced in the construction of the 110th street siphon under the Lexington avenue subway, which is the largest ever built in connection with subway work. The 110th street sewer which it replaces is a horse-shoe section, 8 ft. high by 12 ft. wide. To have lowered the subway sufficiently to allow the sewer to cross over the roof would have entailed an additional cost of $800,000 and to divert the sewer elsewhere would have involved an expenditure of $1,200,000, and, moreover, on account of its flat grade, would have required an excessive maintenance cost. The solution adopted consisted in the construction of two inverted siphons, one at 106th street and the other at 110th street, both crossing under the Lexington avenue subway, at a combined cost of $71,000 and a maintenance charge probably little in excess of any other sewer.

Publications Received

Hubbard's Laboratory Manual, $1.50 net. John Wiley & Sons, New York.

"Municipal Engineering Practice," by A. Prescott Folwell, is a book of 422 pp., published by John Wiley & Sons, for $3.50 net on practice in municipal lines other than street paving, water supply and sewerage, which are treated in three other books by the same author.

"Standard Methods for the Examination of Water and Sewage," adopted by the American Public Health Association, are published by the association in a cloth-bound book of 115 pp., for $1.25. The third edition is just issued as revised to April, 1916. Address 126 Massachusetts avenue, Boston, Mass.

"Municipal Functions," by Herman G. Jones, J. D., Ph. D., is a volume in the National Municipal League series, edited by Clinton Rogers Woodruff and published by D. Appleton & Co., New York. Cloth, 369 pp.

"Town Planning for Small Communities," by Charles S. Bird, Jr., chairman of the Walpole, Mass., town planning committee, is a volume in the National Municipal League series, edited by Clinton Rogers Woodruff, and published by D. Appleton & Co., New York. Cloth, 492 pp.

"Paving Economy, Road and Street," is a paper-bound book of 98 pages, by Charles A. Mullen, director of the paving department of the Milton Hersey Company, Montreal, Que., the argument of which leads to the asphalt pavement.

"Public Utility Rates," a discussion of the principles and practice underlying charges for water, gas, electricity, communication and Transportation services, by Harry Barker, B. S. Cloth, 387 pp., $4. McGraw-Hill Book Company, New York.

Pavement Design and Construction

Methods Employed in Hurried Road Construction at Mount Gretna (Pa.) Military Camp

Plans for road building at the Mount Gretna camp contemplated the completion each week of two miles of water-bound macadam road 16 ft. wide. The total length of the road is 6½ miles. George H. Biles, Second Deputy State Highway Commissioner, in direct charge, was five days ahead of schedule when a five-day rain set in.

Machinery and Blasting

There are 300 laborers living under tents erected according to military regulations. The State Highway Department equipment on the ground includes 12 traction engines, 10 rollers, 13 scrapers, 31 dumpwagons, 22 auto trucks, 7 rooter plows, 9 sprinklers, 1 scarifier, 4 harrows, 4 drag scoops and 1 gasoline pump. At the time of writing 20 car-loads of material are arriving on the job daily.

The slag pile at Lebanon was practically commandeered. Effort to blast the crust of the slag with dynamite were abandoned as the dynamite spread its force through the loose slag under the crust. A well-drilling outfit was put in and, after drilling holes thru the hardened crust and the loosened slag, successfully broke up the mass with black powder.

Construction Methods Employed

The hurry-up construction methods employed are described as follows by Second Deputy State Highway Commissioner Biles:

Clearing and Grubbing

The work embodies principally the complete opening up of new right-of-way, which requires that various operations must be carried on in order, namely, the section must first be brushed, trees removed and stumps and rocks blasted out before the actual grading work can be taken up. Upon some of the sections this work is of magnitude and requires a large organization to accomplish satisfactory results. When the right of way has thus been cleared, traction engines, with rooter plows, are started in completely to loosen up the surface. This is followed by traction engines and road machines, or graders, which complete the removal of the necessary material to the grade lines.

Preparation of Subgrade

All craters left by the removal of stumps and large rocks are filled with stone in order to ensure a solid subgrade. Drains and culverts then are placed at the proper locations and after this the large power rollers are put in operation and the surface is thoroly compacted. Upon the sub-base, after being properly prepared, the slag, which is being used for the base construction, is deposited in the center of the road in continuous stretches. This material is spread in two layers by these machines, which are drawn by traction engines, each layer being thoroughly rolled, and upon completion being about eight inches in depth.

With the final rolling of the slag base, the surface of the slag is sprinkled, which tends to solidify, or cement, the material more uniformly. Upon this surface is deposited, in continuous piles along the center of the road, the same as was done with the slag, trap rock ballast. This also is spread in place with the use of traction engines and road machines, to a depth of about 5 in.

Placing First Course

When the proper amount of material is secured and the spreading is completed, a spike-tooth harrow, weighing about 400 lbs., is drawn over the surface of the road, back and forth, which segregates the stone and eliminates the possibility of loose pockets. This operation is continued until the teeth of the harrow practically ride on the upper surface of the stone. Stone screenings then are spread lightly from piles at the sides and followed by sprinkling and rolling alternately, adding the necessary amount of screenings during the operation, in order to bond up the ballast stone thoroly. This course is 4 in. in depth when compacted. The rolling and sprinkling are continued until a surface mortar is produced and the road shows no wave under the operation of the roller. When this is completed, the surface then is to be opened to traffic for a few days and thereafter given an additional rolling and finishing, in order to compact uniformly and completely all portions of the surface.

Finished Surface

Upon the finished road surface, after the fine material has been swept off, a bituminous treatment of four-tenths of a gallon to the square yard is applied with motor pressure distributor, using Department Class "C" specification material, and covered with trap rock chips in quantities ranging from 15 to 20 lbs. to the square yard, applied with mechanical spreaders.

Recommended Changes in Testing Road Materials

Certain changes in the approved methods of testing road materials were recently recommended by Committee D-4 of the American Society for Testing Materials.

Standard Test of Rock Toughness

As the result of over nine years experience in routine testing laboratories and of a considerable amount of investigative work, it has been thought desirable to revise the present standard test for toughness of macadam rock, giving more complete and specific directions in connection therewith, and at the same time making the test more serviceable for ascertaining the relative toughness of different rocks. The committee recommends a revised test in Appendix I of the report which can be obtained from Provost Hubbard, secretary of Committee D-4, Office of Public Roads and Rural Engineering, Washington, D. C. Other appendices here mentioned may be obtained in a similar manner.

Testing Specific Gravity of Coarse Aggregates

In its 1916 report, Committee D-4 proposed a standard test for the determination of the apparent specific gravity of homogeneous coarse aggregates which was published as tentative. While it is believed that this test is satisfactory for aggregates which are absolutely homogeneous, recent investigations have demonstrated that the homogeneity of an aggregate is frequently difficult to ascertain, a revised tentative test is recommended in Appendix II of the full report. The revised tentative test is suitable not only for homogeneous but also for non-homogeneous coarse aggregate.

Distillation of Bituminous Materials

In 1916 the society adopted a standard method for the distillation of bituminous materials suitable for road treat-

ment. This method describes and specifies the thermometer which is to be used in the test in view of the fact that a number of committees have recommended specifications for distillation thermometers which do not defer materially in essential requirements, but only in wording and minor details, a conference committee was appointed to consider the existing specifications for distillation thermometers, and to present, if possible, a single specification to replace the three previously reported. Revised thermometer specifications are given in Appendix III.

Standard Definitions of Terms

The Joint Conference Committee has given further consideration during the past year to the terms, Aggregate, Bank Gravel, Screen and Sieve, and has proposed the following definitions, which have been accepted by Committee D-4, and are recommended for publication as tentative for the customary prescribed period before referring them to letter ballot of the Society:

Aggregate: The inert material, such as sand, gravel, shell, slag or broken stone, or combination thereof, with which the cementing material is mixed to form a mortar or concrete.

Screen: In laboratory work an apparatus, in which the apertures are circular, for separating sizes of material.

Sieve: In laboratory work an apparatus, in which the apertures are square, for separating sizes of material.

Bank Gravel: Gravel found in natural deposits, usually more or less intermixed with fine material, such as sand or clay, or combination thereof; gravelly clay, gravelly sand, clayey gravel and sandy gravel, indicate the varying proportions of the materials in the mixture.

In addition to its recommendations relative to the adoption of the revised standard method of determining the specific gravity of coarse aggregates and the definitions above given, the Joint Conference Committee reports that it has under consideration methods proposed by Committee D-4 for the determination of the specific gravity of sand and other fine highway material, and of voids in mineral aggregates; that it also has under consideration definitions for filler, grit, loam, screenings, and silt. The committee recommends that no definitions be adopted for Gravel, Sand and Clay, and this recommendation has been accepted by Committee D-4. Because of the fact that the interests of both committees are affected by the matter, the Joint Conference Committee has under consideration the standardization of methods for sampling gravel, sand, and similar materials.

British Standard Nomenclature

In view of the fact that the Engineering Standards Committee of Great Britian has published a report upon British Standard Nomenclature of Tars, Pitches, Bitumens and Asphalts, these with comments thereon were referred to the committee for consideration. In Appendix IV of the full report there is a discussion of the British Standard Nomenclature as compared with the nomenclature adopted by the American Society for Testing Materials.

Keep Up Road Work

Our entering into war need not and should not mean a curtailment in road construction and building operations. War does not mean that everybody should forget business and live a life of gloom. Both public and private useful construction ought to proceed. Production and handling of building materials and public and private construction work are fundamental industries of the country. The country is prosperous. Railroads should spare no effort to supply the building industry with the cars needed to transport materials. Government, state, county and municipal authorities should encourage the continuance of all kinds of building. Road and street improvements in particular should go on unabated.

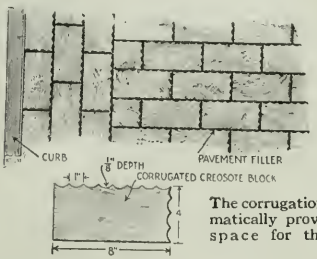
Contractors should make a careful study of conditions that they may encounter and lay plans accordingly. All work possible should be done by labor-saving devices. What may seem a heavy initial expenditure for equipment will very probably prove to be a wise investment before the contract is completed. It is worse than folly to use slow, costly methods.

Joints in Concrete Roads

Road builders have been laying concrete roads for a number of years, but they still differ radically regarding the necessity of leaving joints across the roadways every 30 to 50 ft. to permit the concrete to expand and contract with temperature and moisture changes without cracking. Some engineers believe that these joints do not prevent cracking and that it is better to lay the concrete without joints except where the day's work ends. They believe that the cracks in well-built roads are unimportant, and the most serious objection to them is the appearance of the black streaks across the gray concrete where the cracks are filled with bituminous material and sand by the repairman. They consider that joints merely add to the number of seams that must be filled with this material. The public riding over roads with these black streaks is liable to think that the pavements are failing when they are merely showing the natural effects of the expansion and contraction of concrete. There are more engineers, however, who hold that joints should be left at regular intervals. They are placed about every 30 ft. apart in Connecticut, for instance, where the state road authorities believe that a straight, well-made joint can be much more easily cared for than any ragged crack which might result if no joints were used or if the distance between them were lengthened. The subject is of much interest to road builders, because it is one of those features of their work where only the experience of a number of years will give the knowledge to decide correctly what is the best practice.

Corrugated Wood Paving Block

An interesting step toward the betterment of wood block pavements has been taken by the Jennison-Wright Co., in the manufacture of a corrugated wood block for this work. Each of these blocks is corrugated at one side and one end, by grooves running parallel to the grain of the wood, as shown herewith. The dividing lines between grooves are of "knife-edge" sharpness.



The corrugations automatically provide the space for the filler

The particular advantages claimed in using these blocks in paving work come from the fact that the pavement will not buckle from heat, dampness or other causes that may make the wood swell. All movements of the blocks are absorbed by the compression of the corrugations. Being vertical the grooves also allow the tar filler to flow clear to the bottom of the block, thus sealing the pavement against moisture.

Comprehensive Survey of Deposits of Road-making Materials

An interstate Survey of road materials is under way with Dr. Wm. Bullock Clark, state geologist of Maryland, in charge of geological work, and Henry G. Shirley, chief engineer of the state roads commission of Maryland, in charge of the engineering work. The work is being done at the request of President Wilson to aid the Council of National Defense. The committee investigating road materials is called the Committee on Available Materials for Rapid Railroad Highway and Fortification Construction Behind the Front. The Atlantic and Gulf coast states are being surveyed. The survey, undertaken primarily for military purposes, will make available to the road builders of various localities complete information relative to materials suitable for their needs.

Committee Personnel

The members of the committee are:

Alabama—Prof. E. A. Smith, University; W. S. Keller, state highway engineer, Montgomery. Connecticut—Prof. H. E. Gregory, New Haven; C. J. Bennett, state highway commissioner, Hartford. Delaware—Dr. E. B. Mathews, Johns Hopkins University, Baltimore; James Wilson, highway commissioner, Wilmington. Florida—Dr. E. H. Sellards, Tallahassee. Georgia—Prof. S. W. McCallie, Atlanta; T. P. Stanley, state highway engineer, Athens. Louisiana—Prof. F. V. Emerson, Baton Rouge; W. E. Atkinson, state engineer, New Orleans. Maine—Dr. H. P. Little, Waterville; Prof. W. E. Ford, New Haven, Conn.; Paul D. Sargent, chief engineer, state highway commission, Augusta. Maryland—Dr. Wm. Bullock Clark, Baltimore; H. G. Shirley, chief engineer, state roads commission, Baltimore. Massachusetts—Prof. B. K. Emerson, Amherst; Arthur W. Dean, chief engineer, state highway commission, Boston. Mississippi—E. N. Lowe, Jackson; Xavier A. Kramer, state highway engineer, Magnolia. New Hampshire—Dr. J. W. Goldthwait, Hanover; F. E. Everett, state highway commissioner, Concord. New Jersey—Dr. H. B. Kummel, Trenton; R. A. Meeker, state highway engineer, Trenton. New York—Dr. C. P. Berkey, New York; E. A. Duffey, state highway commissioner, Albany. North Carolina—Dr. Joseph Hyde Pratt, Chapel Hill; W. S. Fallis, state highway engineer, Raleigh. Pennsylvania—Dr. R. A. F. Penrose, Jr., Philadelphia; W. D. Uhler, chief engineer, state highway department, Harrisburgh. Rhode Island—Dr. Charles W. Brown, Providence; I. W. Patterson, chief engineer, state board of public roads, Providence. South Carolina—Prof. Stephen Taber, Columbia; J. Roy Pennell, state highway engineer, Columbia. Virginia—Dr. Thomas L. Watson, Charlottesville; G. P. Coleman, state highway commissioner, Richmond. Texas—Prof. J. Udden, Austin; Prof. R. L. Morrison, College Station.

For a National System of Highways

All the states now have state highway departments and have adopted the policy of building state systems of main, thru-line highways. There is also a Federal Aid Road Act on the statute books. Therefore the stage is set for the final act—the establishment of a national system of highways. The next logical step is the broadening of federal participation to provide for the establishment of a system of national highways. This policy can be put into effect without disturbance of existing organizations, without providing new means of finance, and with but little change in existing law. In the judgment of Chairman George C. Diehl, of the Good Roads Board of the American Automobile Association, which was a pioneer exponent of national governmental co-operation with the several states, the process would logically take a course somewhat as follows:

First: The state highway departments and the Federal Office of Public Roads would make an initial selection from existing state highway systems of those highways which are of interstate importance.

Second: A system thus selected would be approved by Congress, with the requirement that federal funds be applied only to such system on and after a specified date.

Third: The federal aid should be extended to maintenance as well as construction, as the national system of highways should have for all time a close relationship to the federal government.

Some of the states have already made plans for utilizing the aid granted by the Federal Aid Road Act on roads which could not properly be included in a national system. But this need not cause extreme conflict, as the federal funds for the first three or four years' operation of the present act could continue to be applied as now planned. The appropriations for the first two years are already available and considerable time necessarily must lapse before the national system could be laid out and made ready for the application of federal funds.

In all probability the new scheme would come into effect as an extension of the present Federal Aid Road Act.

Resolutions Calling for Vigorous Road Building Campaigns

A large number of persons engaged in many professions and callings recently met at Columbus, under the auspices of the Ohio Good Road Federation, and, after a discussion of business conditions in both city and country, adopted the following concise statement of reasons for continuing road work:

Resolved, first, that the efficiency of our industrial, commercial and agricultural activities should not be lessened or handicapped by war hysteria.

Second, that our financial resources are in a healthy condition, no stringency in the money market exists, there is ample employment at good wages for all labor, that the agricultural districts promise an unusual acreage and harvest yield, that every pound of meat and bushel of grain the farm produces can be sold at profit prices, and that none of the factors that usually contribute to business depression now exists.

Third, that any policy of government that retards any useful activity will correspondingly harm other industries.

Fourth, that one great economic need of the farm and farmer is improved highways that will assist in transporting products of farm and garden to the market.

Fifth, that freight congestion in great centers of traffic creates imperative need for good highways to supplement railroads in transporting the products of the industrial and commercial world.

Sixth, that the war in Europe has already demonstrated that good roads are powerful adjuncts in national defense in the movement of armies, war munitions and all military supplies.

Seventh, that good roads are important factors in rural welfare, contentment and vitalizing of rural America; therefore, be it

Resolved, that this conference urge the national and state administrations, state highway department, county commissioners, county surveyors, township trustees and municipal councils to adopt and go forward with a vigorous, progressive road building program. We commend all county commissioners and road builders who have gone forward in road building and are doing their utmost to place Ohio in the lead in the improvement of highways.

WATER WORKS DESIGN AND CONSTRUCTION

Method and Progress of Lining the Wilson Avenue Water Tunnel of the Chicago Water Works

The Wilson avenue tunnel of the Chicago water works is one of the longest tunnels in the world and has many features which make it notable in regard to advanced methods of construction and the record rate of speed at which it is being constructed.

General Features

The tunnel is 8 miles long and 12 ft. in finished diameter for 7 miles of its length and 13 ft. in finished diameter for 1 mile of its length at the lake end. It is located in solid limestone rock about 150 ft. below datum and has a monolithic concrete lining, 1 ft. thick. The outer end of the tunnel is at the new crib in Lake Michigan, 3 miles from the shore at the foot of Wilson avenue. The west end of the tunnel is at the new pumping station at Mayfair, 5 miles west of the shore, and the land section of the tunnel is located directly under Wilson avenue.

The tunnel is being constructed by day labor, with the exception of the crib and about 2,000 ft. of tunnel from the crib west. The work being done by the city is handled thru four construction shafts, one at the extreme west end, the Mayfair shaft; one at Lawndale avenue, one at Lincoln avenue and one at the lake shore. These shafts are a little less than 2 miles apart. The heading east from the shore shaft is therefore about 3 miles in length and is one of the longest headings in the world to be excavated from one shaft.

Concrete Mixed and Placed by Compressed Air

In the early plans for the construction of the tunnel considerable study was given the method of handling the work of mixing and placing the concrete for the lining, as the rock excavated from the tunnel was good limestone and suitable for concrete work, and it was desirable that some method be employed whereby rock could be taken from the heading and used in the concrete without the necessity of removing the rock from the tunnel first and bringing it back again to be placed in the concrete lining. No tunnel had ever been lined in this way before, and it therefore required considerable study for the preparation of plans for a plant which could be used in the tunnel without interfering with traffic from the heading to the shaft, and at the same time utilize the rock direct from the heading.

VIEW SHOWING LINING OF WILSON AVENUE TUNNEL OF THE CHICAGO WATER WORKS BY PNEUMATIC METHOD.
FIG. 1—SCREENING AND MIXING PLANT. FIG. 2—BLAW STEEL LINING FORMS.

The Screening and Mixing Plant

The pneumatic method was decided upon for the work and a pneumatic mixer was mounted on wheels, together with air supply tanks and a measuring hopper located above it. In addition, a belt conveyor outfit, also mounted on wheels, was used to convey the rock from under the screen to the measuring hopper over the mixer. Upon the framework which held

this belt conveyor an electric winch was mounted for hauling 1-cu.yd. cars of mine-run rock up an incline, to be dumped over a flat screen with 4-in. holes. The rock which passed thru the holes fell onto the belt conveyor and was carried up to the measuring hopper. The rejections passed over the screen and fell onto an iron plate laid on the floor and were shoveled from this plate into a car to be hauled out of the tunnel. The entire outfit is shown in Fig. 1. It occupied only one track in the tunnel, so that the other track was never obstructed except by the car which received the rejected rock, and this car pushed to the shaft every time a muck train passed thru, and an empty car was placed in its stead.

The upper large pipe in Fig. 1 is the ventilating pipe carrying fresh air to the heading. The lower large pipe is the mixed concrete discharge pipe. To the left of the latter lies the 2-in. compressed air supply pipe line. The compressed air tank is prominent in the view. The platform at the top of the latter is used for handling the cement bags. This platform was extended across the tunnel section when the unit was set for a long run. The belt conveyor end is shown at the top of the unit.

tunnel was completed. The mixer was then moved 1,000 ft. farther and the same operation was repeated.

The first pneumatic outfit was started working east from the shore shaft in December, 1915. At first a distance of 500 ft. was planned for conveying the concrete, but as this cycle was completed and the mixer moved to the next position, the distance was increased until the experience seemed to determine about 1,000 ft. as the proper maximum distance. The heading at this shaft was about 1 mile ahead of the mixing plant when the concrete work was started. With two 30-ft. forms the progress of the concrete work was about two and one-half to three times the progress of the excavation work, and this machine, therefore, caught up with the heading in about six months and was temporarily closed down until the heading was farther advanced.

In the meantime the heading from the Lincoln shaft was holed thru so that rock could be hauled from the heading east of the shore shaft to be used for the concreting plant which had been started at Lincoln avenue shaft in March, 1916. Ac-

VIEWS SHOWING LINING OF WILSON AVENUE TUNNEL OF THE CHICAGO WATER WORKS BY PNEUMATIC METHOD.
FIG. 3—PLACING THE CONCRETE. FIG. 4—SPECIMEN OF THE CONCRETE.

Forms and Placing

The general plan for proceeding with the concrete work involved the use of the pneumatic mixing plant, as described, and two Blaw traveling steel forms. One of these forms was set about 1,000 ft. away from the mixer and the other form about 500 ft. away—see Fig. 2. The 8-in. pipe for conveying the concrete from the mixer to the forms was laid along the side of the tunnel thru the first form to the second one, and there it was directed up a 45-deg. angle and into the top of the form as shown in the view, Fig. 3. When this form was filled with concrete, the pipe was disconnected and arranged for filling the other form, and as the concrete set the forms were moved alternately toward the mixer, until about 1,000 ft. of

cordingly, the concrete gangs from the two machines were organized into one gang, and one of the forms from the machine in the east heading was taken and set up for the Lincoln machine, thus making three forms to follow the Lincoln avenue machine and only one form for the shore shaft machine. This arrangement made it possible for one gang to operate the two mixers alternately, so that, working three shifts, they were able to fill the three forms at Lincoln avenue and one form at the shore shaft, keeping the concrete work going constantly on one of the two machines. As there were four forms in use, there was no delay caused by waiting for the concrete to set or waiting for the forms to be moved. Each shift the concrete gang found a form moved and the pipe connected up ready to start the concrete work. Each concrete gang completed one form and changed the pipe ready to start the next shift. There was a form-moving extra gang which worked one shift,

moving the forms and placing the sand-bag bulkhead at the forward end.

The machine at Lawndale was started in April, 1915, and the one at Mayfair shortly afterward. Both of these machines used rock from the heading east of the Lawndale shaft as the tunnel had been previously holed thru between the Lawndale and Mayfair shafts.

Concreting the Footing Wall

One of the new features of placing the concrete at the Lawndale shaft was the use of the pneumatic mixer for placing the concrete in the footing wall. This footing wall is usually built by hand in advance of the regular concrete work and is a wall about 1 ft. high, used as a guide for the forms to follow. In placing this at the Lawndale shaft the concrete was first delivered into the Blaw forms by the pneumatic mixers in the regular manner. But a keyplate was left out of the steel forms and a chute was placed in it, operating so that the concrete being placed by the pneumatic method would overflow thru the chute into a car placed beneath the forms under the chute. The car then carried the concrete ahead and dumped it into the forms for the footing wall. In this way the footing wall was placed about three times as fast as it could have been placed by hand.

Organization of Construction Gang

The number of men required for the operation of the concrete work was as follows:

Screening Rock from Heading—
- 3 men pushing up cars to incline, hooking on cable, dumping same on screen and pushing back empty cars to make train bound for the heading.
- 1 man operating motor hoist for pulling cars up incline and for operating belt conveyor for carrying screened rock to hopper over mixer.
- 2 men shoveling rejections from screen into cars to be hauled out of tunnel.

Cement Delivery—
- 2 men unloading cars of cement and storing same on platform above air tanks adjacent to mixer hopper.

Mixing and Placing Concrete—
- 3 men operating hopper over mixer, feeding cement, water and screen run rock.
- 1 man operating mixer, air valves.
- 1 man at end of pipe in concrete form.

When there was sufficient rock on hand for continuous concreting, the forms were filled very rapidly, one form having been filled in one hour and forty minutes. The forms contained from 50 to 70 yds. of concrete, depending upon the excavated section. During January, 1917, one machine at Lincoln avenue placed 2,707 lin. ft. of tunnel lining.

The progress of the work from the beginning of concreting operation is shown in Table I.

TABLE I—MONTHLY PROGRESS OF CONCRETING

Month	Yardage Placed	No. of Mixers
December, 1915	1,400	1
January, 1916	2,196	1
February	2,300	1
March	2,508	1
April	5,911	3
May	2,006	1
June	2,669	2
July	2,953	2
August	330	1
September	2,933	2
October	3,720	2
November	1,352	1
December	8,725	3
January, 1917	11,355	3
February	8,502	2
March	6,311	2
April	3,064	2
May	4,213	2
June	799	1

The rate at which the mixer operates cannot be figured from the data in Table I. Working between 16 and 24 hours a day, one machine, at the Lincoln shaft, put in 2,900 lin. ft. of tunnel in a month and the yardage of the lining runs 2 cu. yds. per lineal foot. The ultimate capacity of the mixer is 60 cu. yds. per hour. A sample of the concrete is shown in Fig. 4.

It should be noted that the Wilson avenue tunnel is the first tunnel in which the concrete work was carried on simultaneously with the mining and using the mine-run rock excavated from the heading for the concrete work. The use of the pneumatic method made this possible and saved over one year in constructing the tunnel.

Personnel

The pneumatic mixers are patented and are leased to the city by the Concrete Mixing and Placing Company, of Chicago. The work of constructing the tunnel is carried on by the Department of Public Works, Bureau of Engineering, Water Works Construction Division, with Mr. Henry W. Clausen in charge as engineer of water works construction. Mr. John Ericson is city engineer in charge of the Bureau of Engineering, and Mr. F. I. Bennett is commissioner of public works.

TRADE NOTES

Announcement is made of the removal of the San Francisco office of the Sullivan Machinery Company from the Sheldon building, 461 Market street, to the Hobart building, at 582 Market street. The manager of this branch office is Ray P. McGrath.

At a recent meeting of the board of directors of the Ingersoll-Rand Company, J. H. Jowett, formerly general sales manager, was elected vice president of the company. Mr. Jowett was succeeded in the position of general sales manager by L. D. Albin, formerly assistant general sales manager. Both of these gentlemen will continue to make their headquarters at 11 Broadway, New York City.

The Walter A. Zelnicker Supply Company, 325 Locust street, St. Louis, Mo., has just issued its new Bulletin No. 221, listing exceptional offerings in pipe, tanks, piling, rails, cranes, cars and locomotives. It is free for the asking.

Pauling & Harnishfeger, of Milwaukee, have orders booked that will keep their plant busy for nine months. They have only one 40-ft. 1-cu.yd. drag line, a couple of 12-ft. ladder type excavators and backfillers for delivery. A new lot of twenty-five tampers recently completed were half sold before they were finished. This is the last bunch to be put thru before snow flies. Any water department needing a tamper should get their order in now. P. & H. are quoting now for 1918 on excavators.

A preparation called "Rasindia," guaranteed to erase India ink from tracing cloth, is manufactured by E. H. Anderson, at 272 East 199th street, New York City. A 3-oz. bottle sells at $1. It is claimed that this erasing fluid leaves no trace of the ink and does not injure the cloth.

Water Purification and Sewage Treatment

Some Characteristics of the Activated Sludge Process of Sewage Treatment.

By Almon L. Fales, of Metcalf & Eddy, Consulting Engineers, Boston and Chicago.

The most recent development in the art of sewage treatment is the activated sludge process. This method of treatment is unique in that the process may be adapted to accomplish clarification without stability, or it may be carried to the point of producing a stable effluent without much excess of available oxygen, or it may be carried still further to the point of producing a highly nitrified effluent comparable with that from the intermittent filter, said Mr. Fales in an address to the American Chemical Society.

Requisites of Process

The requisites of the activated sludge process are:

1. A sufficient proportion of bacterially-active sludge.
2. Intimate mixture of the activated sludge with the sewage to be treated.
3. A supply of atmospheric oxygen ample for the bacterial demand.
4. A time of contact, or period of aeration sufficient to accomplish the desired degree of purification.
5. A temperature of aeration not too cold nor too warm for bacterial growth.

Activated sludge may be obtained by sufficient aeration of successive portions of sewage. A proportion equivalent to about 25 per cent. of the volume of sewage to be treated, is usually sufficient.

Intimate mixture of the activated sludge with the sewage may be secured by the proper application of the air which is required to support the bacterial life upon which the process depends.

The air must be uniformly distributed through the mixture, in order to supply all parts of the liquid with ample oxygen. A period of aeration of 4 hours appears to be sufficient for ordinary sewage. The indications are that about 1.75 cu. ft. of air per gallon of sewage will suffice under ordinary conditions.

Satisfactory results have been obtained even during winter weather, altho it appears to be difficult to secure nitrification at cold temperatures.

Means of Air Diffusion

Theoretically, at least, the air must be well diffused in order to be used economically, and as the compressed air is one of the chief elements in the cost of sewage treatment by this process, the question of air diffusion is a very important one. Porous plates—of such materials as filtros, corumdum and certain woods—are well adapted for the diffusion of air, but fear is expressed that such materials will become clogged in spite of all precautions, such as washing the air to be applied.

The concensus of opinion at the present time appears to be that something must be sacrificed in theoretical efficiency in favor of the more practical means, such as perforated pipes.

Theory of Action

Activated sludge is a light, flocculent substance, brown in color and earthy in odor. It contains large numbers of bacteria which appear to be essential to the process. When activated sludge is brought into contact with sewage, it will attract and absorb the suspended and colloidal matters and a portion of the dissolved matters, and submit them to bacterial oxidation.

The extent of oxidation of the absorbed organic matters will depend upon the period of contact afforded. It is possible, by lengthening the period of aeration, to secure a large percentage digestion of the sludge, occasioned by the transformation of organic matters into gases. It is possible to carry the aeration to the point of over-activation of the sludge, resulting in the disintegration of the sludge flocculi and a consequently muddy-appearing effluent.

Under-activation is characterized by a darker, more feathery and more voluminous condition of the sludge. If the sludge remains without sufficient air it will become disagreeable in odor, due to putrefaction, and will finally become deactivated.

Method of Operation

The activated sludge process is carried out in tanks operated either on the fill-and-draw plan or upon the continuous-flow principle. In the former case the tank is filled with the sewage, aerated for the required period of time and then allowed to settle, after which the clear, supernatent water is drawn off ready for the next tank-filling. In the latter case, sludge will be carried out of the aeration tank with the effluent and must be removed by sedimentation tanks and returned in proper proportion to the incoming sewage. It may be advantageous to reactivate the sludge so removed, before it is returned to the sewage.

Disposal of Activated Sludge

The activated sludge in excess of that required for the treatment, must be disposed of, and as the volume of such sludge is relatively large, the problem of its disposal is a serious one. Owing to its gelatinous nature and high water content——about 95 per cent.—it does not dry out as readily on sludge-drying beds as some other kinds of sewage sludge. After drying to a spadeable condition it is likely still to contain in the vicinity of 75 per cent. water. It may be readily filter-pressed to about the same water content.

Analyses of dried activated sludge indicate that it has greater fertilizing value than other sewage sludge, owing principally to a larger nitrogen content and a greater proportion of nitrogen available for plant food. Attention is now directed to the problem of dewatering and drying this sludge, at a cost which will either greatly reduce the cost of sludge disposal or actually make sludge disposal commercially profitable.

Interrupted Service Lowers Pump Efficiency

Tests made by A. O. Doane, division engineer of the Metropolitan water district of Massachusetts, show that small pumping stations usually work at a point considerably below the test efficiency, as a result of interrupted service and a load that is considerably under rated capacity.

Mr. Doane's test figures showed that in the smaller plants operating under capacity and working short hours the efficiency frequently fell to 75 per cent. or even 50 per cent. of that shown by test figures, based on the most favorable operation of the pumps.

Some Experiences in Operating the St. Louis Mechanical Filtration Plant

The design and constructional features of the big mechanical filtration plant at the Chain of Rocks station have often been described; the present article relates only to operating methods and experiences. The plant consists of 40 filter units, each of 2,800 sq. ft. of filtering surface.

Stages in the Purification Process

The raw water is pumped from the Mississippi river into a delivery well, flowing by gravity into a grit chamber. Here the velocity is checked and the heavy material deposited, after which the water flows into an 8,000-ft. mixing conduit. On entering this conduit milk of lime is added, and usually, after flowing thru about one-half of the mixing conduit, sulphate of iron is added. After leaving the mixing conduit the water flows into the first two of a series of nine basins, in which is deposited the greater portion of the suspended matter. It is then drawn off into the secondary coagulating basins, where aluminum sulphate is added, and passes directly on the filters. A second dose of aluminum sulphate is sometimes added in the conduit leading to the filters. The filter effluent is collected in a clear water conduit, terminating in a chamber where liquid chlorine is added, when it flows by gravity to the high-service pumps.

Grading the Sand

The sand obtained for the filters did not strictly comply with the specifications, but a better grade was expected to be obtained by washing and scraping off the fine material which would be left on top, and additional sand was placed in the beds for this purpose. This grading was carried on for several weeks after the plant was started, until it developed that further washing and scraping the fine material from the top was unnecessary, as the finer material gave a better effluent in a shorter time, but required more washings, also that the grains of sand would become coated with calcium carbonate, etc., would increase materially in size and lose specific gravity. This would cause some sand to be lost in washing. The water in filtering passes downward thru the 30 in. of sand and 12 in. of gravel and the strainer plates into an underdrain system of cast iron pipes connected to an effluent conduit, with a total loss of head of about 13 ft. The additional information given with reference to experiences in operating this big filter plant is taken from a paper by C. M. Daily, engineer in charge of the supply and purifying section of the St. Louis Water Department, before the Engineers' Club of St. Louis.

Rate Controllers

Small, flexible, cotton-covered bronze wire from the floats to the drums of the controllers were found too stiff and were replaced by No. 16 bass cord. The small pilot tubes would stick and caused considerable trouble at first, but they were finally replaced, by the contractor furnishing them, with smaller ones made of Monel metal, which has worked very satisfactorily. In commencing operation of the plant each controller was adjusted and the filter unit put in service. The time required to put the entire plant in operation was about thirty days. The adjustment and testing of the nine Venturi meters for the raw water, wash water and chemical solution, the orifice for measuring the chemical solution, the recording pressure and elevation gages received attention in the order given. In the meantime the operating force was instructed to wash at a low rate (18 in. vertical rise per minute), and to start the washing very slowly until all the air was expelled from the bed.

Investigating Operating Features

When all the machinery was in working condition, experiments were conducted as rapidly as possible to determine the best method to follow in operating the filters.

Tests for color and turbidity and determinations of the bacterial content of the water were regularly conducted under the direction of the chemist, with the expectation that the results of these tests could be used daily for regulating the plant operation. It was soon evident that the time necessary for the incubation of bacteria brought these results too late to be of direct service, so that modification of the treatment had to depend upon the turbidity and color tests, leaving the bacterial results to follow later.

The following uncertain features in the operation were investigated without any preconceived ideas as to the final results: When a filter should be washed; the amount it should be drawn down before washing; the rate of commencing wash and final rate; the quantity of water to be used; the method of treating the filter bed after washing; the quantity of water that should be wasted after each wash; the rate the filter should be run and the time before raising the rate and the best rate of filtration.

Turbidity Tests

Turbidity tests of the effluent water were taken every ten minutes from the time a filter was put in operation until the rate of filtration fell off, due to clogging of the sand. On several filters operating at different rates the results were erratic in regard to the amount of turbidity. Filters having coarse sand allowed more turbid water to pass than ones having a layer of fine sand on top, the effective size being a poor indicator of the probable results. These results raised the question of at how low a rate a filter should be run to produce the minimum quantity of turbid water and how long it should operate at this rate. Tests were made to clear up these points. The tests showed that a quantity of aluminum sulphate required to produce a heavy floc, about 14 lbs., and filtering at the one-half-million-gallon rate for 40 to 50 minutes, gave the best results, reducing the amount of turbidity often to one-quarter part per million and never exceeding two parts. No advantage was obtained by leaving the bed standing for any length of time after filling.

Filter Washing

At first when a filter needed washing the influent was shut off and the bed allowed to operate until the water fell below the top of the wash water gutter, when the washing was started and the quantity of water above the sand was wasted with the wash water. Numerous tests were made by allowing the filter to run after the influent water was shut off until the bed was drained. The results were uniform, showing a good effluent until the water level was far below the top of the sand, but the imprisoned air in the sand usually broke the film, cracks appearing along the walls and a contraction of the film seemed to cause checks as the water reached a point a few inches above the sand. Undoubtedly a poor effluent would be produced by the water passing through the broken film, but all the water in the underdrain system and gravel must pass before this water could reach the effluent flume, so there was no danger in drawing the water down to within an inch or two of the sand. If the water is drawn below the sand packing occurs and the bed does not break up properly when washing, hence nothing is gained by drawing the water below the film of sand.

The amount of filtrate necessary to be wasted after washing was studied and conclusions reached that it was unnecessary to waste any water with the adopted method of low-rate filtration for one hour and treating each bed after washing. As to the amount of wash water required and the best rate of washing, some uncertainties still exist, and probably will continue to do so, as the kind of material carried in suspension, the time between washings and the quantity of aluminum hydroxide on the sand greatly influences the quantity of

wash water necessary at any rate of washing. At first a low rate of wash was used, about 18 in. vertical rise per minute; this was continued for about six months, resulting in the formation of mud balls varying in size from ⅛ in. in diameter to 1½ in. in diameter, most of them being of the smaller size; the rate was then raised to 21 in., and finally 24 in. per minute vertical rise, at which rate some of the smaller particles of sand would rise nearly to the wash water gutters. The high rate seemed to prevent the increase of mud balls, but did not eliminate the ones already formed. Screens having ¼ in. mesh mounted on wooden frames were drawn thru the sand while washing; usually after screening the sand in this manner from five to ten times, most of the mud balls were removed, but unless there was a very even distribution of wash water spots or hard lumps in the sand would occur.

The washing of a filter seems to be largely a matter of judgment, the rate being governed by the height to which the sand grains rise, but this should not be high enough to allow sand to overflow into the gutters. The higher rates seem to produce the best results with a minimum quantity of water.

In beginning a wash, if the rate is high, violent explosive actions occur in the bed, due to imprisoned air, which in same cases tear large holes in the sand, rolling the film of mud together, producing mud balls and leaving portions of the bed unbroken. This condition was avoided by first starting the wash at a very low rate, about 3 in. vertical rise per minute, and continuing until all the air is expelled. This method also avoids destructive ram action on the strainer system.

Device to Determine Rate of Wash

Some difficulty was experienced by the operators at first in judging the rate at which a filter was being washed. Opening the wash water valve, a certain amount did not always give the same quantity each time, due to difference in elevation of the water in the wash water tanks, and also to the frictional resistance in the bed. This led to the installation of a low friction rotary switch, which was operated by the rocker arm of the recording device of the wash water Venturi meter. This switch controlled a current to three electric lights mounted at the south end of the plant, allowing one lamp, a green one, to light when the rate of wash was between 5,000 and 17,000 g.p.m, and a white lamp to light when the rate was between 16,000 and 20,000 g.p.m.. and a red lamp to light when the rate was above 20,000 g.p.m. These lamps can be seen from any operating table in the plant and allows the operator to wash any filter with a variation of not over 5 per cent in the rate of wash. This device has proven very satisfactory and no inaccuracies of the Venturi meter have resulted from it.

Operating Costs

The average costs for labor, material and general maintenance for the period between June 1, 1915, and April 1, 1916, was $2.47 per 1,000,000 gals. The corresponding figure for the period from April 1, 1916, to April 1, 1917, was $2.05. This cost does not include the lime and iron used in softening and coagulation, but does include the aluminum sulphate and chlorine.

During the year ending April 1, 1916, 1.84 grains of sulphate of iron and 5.57 grains of lime were used per gallon of water pumped into the basins; during the year ending April 1, 1917, 0.72 grain of sulphate of iron and 5.23 grains of lime per gallon were used, making a total cost of purifying the water before adding the aluminum sulphate at the filter plant, for the year ending April 1, 1916, $4.37, and for the year ending April 1, 1917, $3.54 per 1,000,000 gals.

Refuse Collection and Disposal

Effect of the War on Garbage Disposal

Before the war writers on garbage disposal frequently called attention to the fact that the disposal of garbage by the reduction method was as distinctly an American institution as the rich American garbage can itself. This method of garbage disposal presupposes wasteful cooking, if it is to be operated on a financially feasible basis.

Just as European garbage was too lean to make the reduction method advisable, the thrift movement in America is now causing a realignment in the selection of garbage disposal methods. In Chicago the weight of the garbage collected for reduction at the city plant has decreased by 50 per cent in recent months. It is doubtful if the American garbage can will be as rich in fats in future as it has been in the past. All these considerations should prompt engineers to revise their ideas about the relative economic advantages of the various garbage disposal methods available.

The Department of Agriculture of the federal government has recently issued some suggestions on the collection and disposal of garbage in the light of war-time conditions. It is suggested that the city food chemist analyze the city garbage from week to week and publish what he finds as an index of food saving or waste in the community. Where there is no official chemist, local chemists competent to determine percentages of fats, protein, starch and organic matter wasted in garbage can render patriotic service by making such analyses in their localities.

One of the first results from the careful analysis of city garbage should be the passage of more rigid enforcement of garbage-collection ordinances, requiring that no glass, tin, wood, burnt matches, paper, string or inorganic trash be mixed with the vegetable material, meat scraps or bones, which can be used for feed.

This dual collection of garbage and trash is being rigidly enforced by Germany in all cities of 40,000 people. Garbage so collected from a population of 17,000,000 people in Germany, although the German garbage pail always has been leaner than the American one, and is especially light at this period, furnished briquettes rich in protein, which, when fed to dairy cattle, produced 1,500,000 to 2,000,000 quarts of milk daily.

In many American cities, however, garbage is sent to reduction plants, where all the fat and oil it contains is recovered for use in making soap or greases.

The residue after the oil is extracted is used as fertilizer or dumped into the ocean. This practice has been profitable because the American garbage pail is very rich in fat, American garbage averaging 3 per cent of fat, while German garbage rarely shows even 1 per cent of fat, as the German people never have been wasteful of animal or other fats. Another

reason for the use of the reduction method is that in many cities ordinances prevent the use of garbage for feeding animals, particularly dairy cows, although there is no valid hygienic objection to the use of dried and properly sterilized garbage as food for cattle or hogs.

The department specialists believe that as the thrift idea gains ground less and less fat will be thrown into the garbage pail, and are hopeful that the time is not far distant when the amount of fat will make reduction for the recovery of oils hardly worth while. This will mean that a lot of excellent and valuable foodstuff now being wasted as food will never get into the garbage pail. Even when all fat is eliminated, however, and waste of bread and cereals and meat has been reduced to a minimum, the garbage pail nevertheless will contain in the form of parings, plate scraps and trimmings a vast amount of material which must be disposed of by incineration, burial or feeding to domestic animals.

Motor Haulage Reduces Garbage Collection Cost 50 Percent in San Antonio

The cost of hauling garbage in San Antonio, Tex., was recently reduced 50 per cent by the use of automobile trucks and trailers. This innovation, introduced by Commissioner of Parks and Sanitation Lambert, also doubled the efficiency of the collection service. A thoro trial of the new method of hauling shows that two Ford trucks, each pulling three trailers, and employing four men for eight hours each, do just twice as much work as the same men with ordinary horse-drawn collection wagons in the same length of time.

Motor Haulage of Garbage at San Antonio.

Fig. 1—A Loaded Train. Fig. 2—Dumping the Trailers. Fig. 3—Dumping the Motor by Its Own Power.

The trucks, with their trailers, leave the shop at 8 a. m. with their drivers and two extra men for loading. The extra men, working rapidly, dump house garbage cans into one of the trucks and its trailers as they move along. When one train is loaded the driver takes it to the dump, while the other driver and the two extra men are loading another train. By the time the second train is loaded the first returns empty, ready for loading again. By this scheme the men and machinery are busy all the time. The trucks each have a capacity of 134 cu. ft. and each trailer has a capacity of 74 cu. ft.

The unloading operations have been greatly expedited by an invention of Commissioner Lambert. A cable runs along the bottom of the truck and attaches to a movable steel skeleton dashboard in front of the truck bed. This is snapped to another cable attached to a dead man, and as the truck moves forward the movable dashboard is drawn toward the rear of the truck, pushing the garbage out in front of it. The back of the truck is 8 in. wider than the front. This prevents jamming during the unloading and permits the garbage to spread out without running over the sideboards. The trailers are dumped in ten seconds. Each is balanced on two wheels, and, when unhitched, dumps of itself.

Three views of these garbage hauling units are shown herewith.

Municipal Garbage Piggery Successfully Operated at Hull, Mass.

A drove of 325 hogs is turning garbage into pork and providing cheaper disposal of the waste than was possible under the former garbage reduction methods in vogue in Hull, Mass. Hulls municipal or community piggery has been undertaken in response to appeals for more meat production, and officials of the United States Department of Agriculture and of the Massachusetts Agricultural College report the system as practical.

The towns committee of public safety advanced the money to buy the young pigs, which were taken at cost by citizens. The land for pasturing and housing the hogs was given free, so the only cost was for two large hog houses. One man feeds and manages the entire herd. Each day the uneaten garbage is taken away before any more is fed; all hogs are inoculated against cholera and are kept under sanitary conditions.

When the hogs are ready for market the unit cost of care and feeding will be shared equally by the owners, and this sum, plus the original cost of the pig, will be the only expense to the owners. The public safety committee is holding a surplus of young sows for breeding, since it plans to continue the system. Citizens of this town extol the advantages of its garbage disposal and recommend it for other places of similar size.

Purification of Creamery Refuse

> The pumps in our creamery have a capacity of 50 gallons of water a minute. In addition to that, we are making about 100,000 pounds of butter weekly. A part of our buttermilk is condensed for feeding purposes, still a large part is run into the sewer.. We would like to build a septic tank of the Imhoff type to make the sanitary condition right for discharge.
>
> L., ———, Ind.,

If a tank of the Imhoff type is to be used, the Pacific Flush Tank Company, 149 Broadway, New York City, should be consulted, as they control the Imhoff tank in this country. As to design of septic tanks or Imhoff tanks, any of the engineers specializing in sewerage and sewage disposal, whose names are found in the Business Directory published in each number of Municipal Engineering, under the heading Consulting Engineers, will give good service.

From Workers in Field and Office

A Federal Waterways Commission

The Editor of Municipal Engineering:

Sir—

A most attractive feature in connection with recent activities at Washington is the amendment to the River and Harbor Bill, which has passed both houses of Congress, creating a waterways commission to study the entire question and co-operate with all agencies, including municipalities, in the study of the water resources of the country. The amendment follows:

Amendment to Rivers and Harbors Bill, Creating a Waterways Commission

Sec. 19. That a commission, to be known as the *Waterways Commission*, consisting of seven members to be appointed by the President of the United States, at least one of whom shall be chosen from the active or retired list of the Engineer Corps of the Army, at least one of whom shall be an expert hydraulic engineer from civil life, and the remaining five of whom may each be selected either from civil life or the public service, is hereby created and authorized, under such rules and regulations as the President may prescribe, and subject to the approval of the heads of the several executive departments concerned, to bring into co-ordination and co-operation the engineering, scientific and constructive services, bureaus, boards and commissions of the several governmental departments of the United States and commissions created by Congress that relate to the study, development or control of waterways and water resources and subjects related thereto, or to the development and regulation of interstate and foreign commerce, with a view to uniting such services in investigating, with respect to all watersheds in the United States, questions relating to the development, improvement, regulation and control of navigation as a part of interstate and foreign commerce, including therein the related questions of irrigation, drainage, forestry, arid and swamp land reclamation, clarification of streams, regulation of flow, control of floods, utilization of water power, prevention of soil erosion and waste, storage and conservation of water for *agricultural, industrial, municipal and domestic uses*, co-operation of railways and waterways, and promotion of terminal and transfer facilities, to secure the necessary data, and to formulate and report to Congress, as early as practicable, a comprehensive plan or plans for the development of waterways and the water resources of the United States for the purposes of navigation and for every useful purpose, and recommendations for the modification or discontinuance of any project herein or heretofore adopted. Any member appointed from the retired list shall receive the same pay and allowances as he would if on the active list, and no member selected from the public service shall receive additional compensation for services on said commission, and members selected from civil life shall receive compensation of $7,500 per annum.

In all matters done, or to be done, under this section relating to any of the subjects, investigations, or questions to be considered hereunder, and in formulating plans, and in the preparation of a report or reports, as herein provided, consideration shall be given to all matters which are to be undertaken, either independently by the United States or by co-operation between the United States and the several States, political subdivisions thereof, municipalities, communities, corporations and individuals within the jurisdiction, powers and rights of each, respectively, and with a view to assigning to the United States such portion of such development, promotion, regulation and control as may be undertaken by the United States, and to the States, political subdivisions thereof, municipalities, communities, corporations and individuals such portions as belong to their respective jurisdictions, rights and interests.

The commission is authorized to employ, or retain, and fix the compensation for the services of such engineers, transportation experts, experts in water development and utilization and constructors of eminence as it may deem necessary to make such investigations and to carry out the purposes of this section. And in order to defray the expenses made necessary by the provisions of this section there is hereby authorized to be appropriated such sums as Congress may hereafter determine, and the sum of $100,000 is hereby appropriated, available until expended, to be paid out upon warrants drawn on the Secretary of the Treasury by the chairman of said commission.

The commission shall have power to make every expenditure requisite for and incident to its authorized work, and to employ in the District of Columbia and in the field such clerical, legal, engineering, artistic and expert services as it may deem advisable, including the payment of per diem in lieu of subsistence for employes engaged in field work or traveling on official business, rent of offices in the District of Columbia and in the field, and the purchase of books, maps and office equipment.

Nothing herein contained shall be construed to delay, prevent or interfere with the completion of any survey, investigation, project or work herein or heretofore or hereafter adopted or authorized upon or for the improvement of any of the rivers or harbors of the United States or with legislative action upon reports heretofore or hereafter presented.

It is hoped that the President will appoint competent engineers on this commission. They have a great opportunity which if well used will be of inestimable value to the country, but if the members of the commission are not thoroughly awake and competent the results may be disastrous.

F. H. Newell.

Cautions for Shovel Runners

The Editor of Municipal Engineering:

Sir—

Cautions for shovel runners are never out of place. It seems to me that it would be a good idea to have this notice that appeared a short time ago in a steam shovel paper printed or typewritten and pasted up where the shovel runner could not help seeing it. Here are the cautions:

"When moving a shovel back it is important to keep the dipper as close as possible to the bottom of the cut without interfering with the track. Don't have the dipper hanging with steam on the crowding engines. While the machine is standing waiting for a track to be laid the steam naturally gets down in the boiler and the fire will be bad. When you start to move, therefore, a great portion of the power will be

taken from the crowding engines and the dipper will drop, endangering those who are in front of the shovel and tearing up the track.

"Another important thing to remember is not to neglect to chain the circle, in order to keep the boom from swinging. For when the shovel is being moved the back end may get off the track, the shovel may settle on one side or a rail may break, which would be apt to cause the shovel to start to tip over. Nine times out of ten there would be water in the swinging engines as the shovel has probably been standing by while the track was being laid. Hence there would be no power to swing the boom back and balance the machine. As a matter of fact, even tho there were live steam, it would be very difficult to keep from losing control when the boom has swung far over to the side.

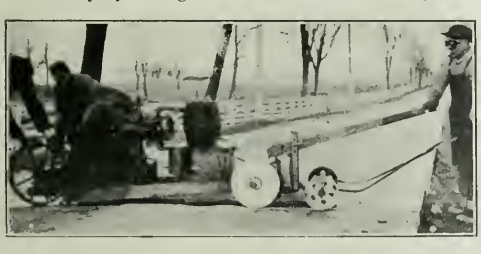
"To prevent absolutely such an accident as this, it only takes a few minutes to fasten one end of the chain over the A-frame and the other end to the turn buckle clevis on the circle. By so doing you will not only save yourself from the possibility of accident, but you will probably save the firm for whom you are working much money and valuable time."

AN OLD SHOVEL OPERATOR.

Device for Grinding Steel Plates in Concrete

The Editor of MUNICIPAL ENGINEERING:

Sir—I send you herewith a picture of the apparatus used on the Dixie Highway in Kenton county for grinding steel plates in concrete road construction. A 6-h.p. gasoline engine is used, having a 24-in. drive wheel, belted to a 4-in. pulley, carrying a 15-in. by 3-in. emery wheel. The outfit is mounted on a four-wheel frame, which is underslung from the rear axle. The center of gravity of the outfit is low and can be guided easily by a tongue attached to the front. By means



STEEL PLATE GRINDER FOR ROAD WORK.

of a lever the emery wheel can be forced down against the plate, very little pressure being required for heavy grinding. Water is supplied to the wheel from a keg on the frame. The complete outfit weighs about a thousand pounds and can be handled easily by two men, although sometimes three are used. Where grinding involves concrete as well as steel, the concrete is first cut away with a coldchisel, thus exposing the steel to the emery wheel. Recently on a job twenty-two joints were ground down, with two and sometimes three men working, in six days.

M. D. ROSS, Newport, Ky.,
Division Engineer, Department of Public Roads.

Trucks Operate on Distillate

The Editor of MUNICIPAL ENGINEERING:

Sir—Of the sixty-six automobiles owned by the municipal light department of the city of Los Angeles, Cal., twenty-eight are trucks ranging from one to four tons capacity. They consist of Morelands, Autocars, Republics and Vims. The trucks are operated exclusively on distillate, a 500-gallon tank being sunk in the yard for distillate, while a 500-gallon tank for gasoline to operate the passenger cars is also sunk in the ground near the garage. It is found that distillate is entirely satisfactory. This fuel at 9 cents per gallon has been tested and found to give as good service as gasoline at 19 cents per gallon, thus making a saving of about half.

The department is now experimenting with distillate for the use of the passenger cars. The trucks are used to haul material and supplies from the warehouse over the system for a distance of 60 miles from Los Angeles. Material for the rest of the line is hauled from the other end of the system. Every morning seven or eight heavy trucks leave the central warehouse loaded with supplies and material, while a number of trucks are fitted up with linemen's supplies, etc.

Fords for "Trouble Shooters."

The passenger cars are mostly Fords and are used for the heads of departments, solicitors, trouble shooters, etc. The trouble shooters follow the transmission line as far as they can on cars, then they walk or use mules where cars cannot go. A gang of trouble shooters is maintained at Los Angeles and one at the San Fernando switching station, who patrol a definite stretch of the line every day looking for trouble along the line. There are two transmission lines, one on each side of the transmission towers, and when there is trouble on one line, power can be switched to the other line. This switching station is used in switching power from one line to another in such cases. It is also used for tests of line trouble. In case there is trouble that cannot be located, the transmission line can be tested both ways. There were approximately 285 miles of transmission wire used. This was all contracted for long before the war, so a great saving was made, as the wire at present is much higher than at the time it was contracted for.

Equipped with Movable Shelving.

There is also a complete carpenter shop and saw mill on the grounds which do all woodwork. The general warehouse and offices are housed in a two-story building, 80x120 feet, which was built in 1916. All supplies and equipment for the system are stored here. A spur railroad track enters the building. This building is equipped with an efficient pneumatic elevator. Here are stored transformer oil, transmission and guy wire. There are 3,600 bales of copper wire for the distributing system. There are also transformers for distribution, ranging from 3 to 50 k.w.; street lighting fixtures, incandescent lamps, meters, bolts and miscellaneous hardware. The bolts and miscellaneous hardware are stored in bulkheads. There is no shelving built into the warehouse, all are movable units so they can be adjusted to any purpose. On the second floor in this building there has been fitted up a room for laboratory purposes and for testing meters and transformers. A special rack built of angle iron is used for storing meters. One and one-half-inch pipes are set up for supports at a distance of every 8 feet; 2½x2½-inch angle iron 8 feet long is attached to the end of the upright pipe by means of U-bolts. Special clamps made to fit over the edge of the angle iron are used for hanging the meters on. There are twelve angle irons to each unit; each unit is capable of holding 320 meters.

Materials Purchased by Requisition.

During the construction of the aqueduct, all purchases of material originated by requisition, which was signed by the division engineer or superintendent and approved by the office engineer or chief storekeeper. When purchased, the goods were shipped direct to the division requiring them, or in case of stock articles were delivered to the Los Angeles warehouse. Engineers desiring shipments from the Los Angeles warehouse made a warehouse requisition, which was approved by the office engineer and chief storekeeper before being filled by the local storekeeper. Shipment was then made to the division, and record made on the department transfer.

The material on each division was carried in a division warehouse. When the foreman on the work required supplies,

he requisitioned them, in duplicate, noting the work order to be charged.

On the first of each year an inventory was made of all material on hand in the different warehouses. These were matched against the ledger balances shown in the accounting department against the several divisions.

Charles W. Geiger, Los Angeles, Cal.

A Refuse Collection Wagon in Successful Use in Dallas, Tex.

To the Editor of Municipal Engineering:

Sir—Herewith please find drawing of improved refuse collection wagon designed for use in Dallas, Tex.

As the bulk of our refuse in Dallas is made up of trash with few ashes, and with a small percentage of garbage, our problem was one of finding a wagon of such capacity that the driver could spend more time on his collection route than heretofore. Each driver makes two trips per day, and often has collected and dumped his load even after a long haul by 11 a. m., and on his second trip by 4 p. m. The lost hours could have been put in collecting refuse if he had had sufficient wagon capacity. This improved wagon has a 50 per cent. greater capacity than the wagons now in general use.

The wagon is underslung so as to bring the loading edge near the ground, and in most instances where the wagon is drawn up to the curb the loading edge is less than 5 feet high. The wagon is designed to unload at the rear. It has tight wooden covers built in three sections, as shown, which rest on T-bars. Because of dead alleys and narrow streets the cut-under front-wheel feature is added to facilitate turning.

A wagon body having closed covers as shown, but for use on ordinary running gear, has been built and put in service in Dallas, and is giving satisfaction. The loading edge, however, on the wagon already built is somewhat higher than on the one shown on the accompanying drawing.

The new type of wagon has the additional advantage that it can be converted into a bottom-dump wagon at any time, for use in connection with dumping platform for a modern incinerator.

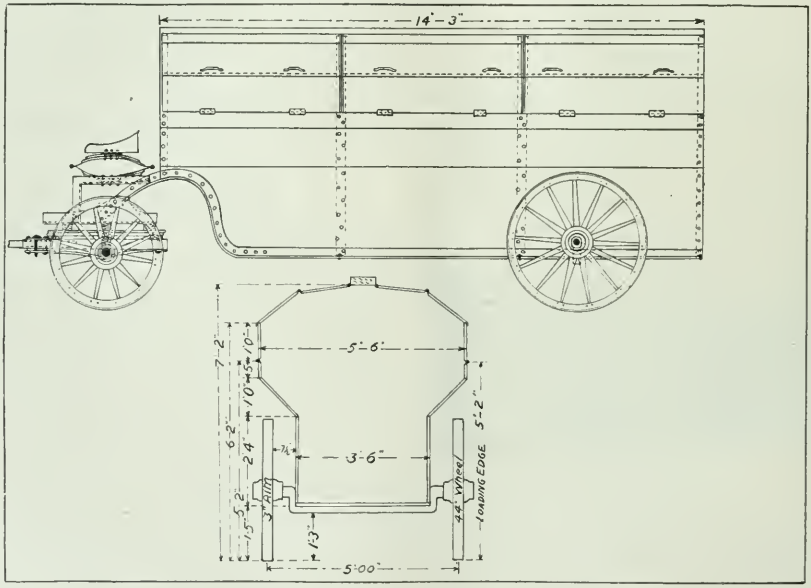
The wagon is designed for standard wheel gage so it can be used in muddy weather, but for use in paved sections of the town the wagon width of 5 ft. 6 in. might be maintained instead of being reduced to 3 ft. 6 in.

H. W. Van Hovenberg,
Dept. of Public Health, Dallas, Tex.

Pavement in Franchise War

To the Editor of Municipal Engineering:

Sir—As the result of a recent Ohio franchise dispute, the citizens of Stark county put complete reliance on motor haulage to banish fear of arbitrary traction measures. The following data were supplied by L. A. Leonard, county commissioner of Stark county, and are of special interest. Mr. Leonard says that when an intercity highway attracts a traffic of several hundred vehicles per hour—when it knits the interests of two neighboring communities and leads to a suburban residence development beyond all anticipation—it would seem that the road in question had amply proved its value.



SKETCH OF IMPROVED REFUSE WAGON USED BY DALLAS, TEX.

In the case of the Canton-Massillon highway, in Stark county, Ohio, the public has another reason for pride and esteem in a public thorofare. This road (and the fact that it is improved so splendidly with brick) constituted the big card in the hands of the public during a long controversy with the Northern Ohio Traction and Light Company, which owns an interurban railroad connecting the two cities. The merits of the controversy are up to the Supreme Court of the United States, and either party may be in the right so far as the subject matter is concerned.

County Commissioner Leonard points out that one of the cards which a traction company holds is its ability to discon-

tinue service, to lessen its convenience or to increase the fare, thus disrupting the daily life of those who depend upon it and forcing a speedy compromise on the part of the public. In the present case no such threats have had any efficacy for the simple reason that the motor-bus service between the two cities over the Canton-Massillon highway is substantially as good and 5 cents cheaper than that afforded by the electric railway. The owners of a rapidly increasing number of private autos are also rendered independent of railway service, and there is nothing for the company to do, even if it desired otherwise, but to wait for the proper tribunals to give their decisions on the various points at issue.

It is stated that during the December blizzard of last year traction service was completely at a standstill for two days, not merely between the two cities, but on the city lines of Canton as well. Nevertheless, the motor busses plowed thru the snowdrifts and scarcely one of the hundreds of interurban wayfarers missed an appointment as a result of the traction tie-up. The highway in question is eight miles in length and a part of the Lincoln Highway route. It was improved under a comprehensive plan that included provision for two 18-ft. brick pavements, with the railway tracks in the center of the road. The road was widened uniformly to 66 ft., and in some places, where turns and jogs were straightened, it assumed a width of more than 100 ft. Only the south driveway was paved at first and the consummation of the plan partially defeated by the traction company, which persisted in maintaining its tracks at the northern edge of the road. One of the contentions of the county has been for the removal of the tracks to the center of the road and some financial assistance from the traction company in paving the northern half of the roadway, this payment being a sort of track rental.

Considering the enthusiasm which this admirably paved highway now inspires, it seems strange to recall that there was open hostility to the paving plan when it was first broached. It took a patient and enthusiastic canvass on the part of Charles L. Stoner, then clerk of the county commissioners, to enlist the abutting property owners in the support of the plan. At length 80 per cent. signed up, moved in part by a promise of $75,000 in state aid. Even after construction commenced there was opposition to the straightening and widening of the road by some abutting owners. In one instance the pavement was completed up to a property line and was left there, barricaded by a clay bank, until public sentiment shamed the obdurate owner into withdrawing his opposition. To-day, any one who opposed the idea of an intercity pavement would be examined as to his sanity.

FRANK C. PERKINS.

Why Cities Should Continue Making Public Improvements in War Time

Should cities continue making public improvements or "sit tight" until the war is over, before going on with the construction of public works? Three correspondents have written the editor on this subject and their views follow:

The Editor of MUNICIPAL ENGINEERING:

Sir—

There are many reasons why cities should continue making public improvements without waiting to see how the war turns out. Roads, bridges and other public improvements are going to be needed during and after the war as much as ever, and we can see no reason why their construction should be discontinued.

There is a large amount of capital invested in plants and equipment for the handling of this character of work, and this capital should be kept busy the same as in any other line of business endeavor. Not all of us are going to be permitted to go into the trenches, and with the heavy drain of the war it is going to be necessary to speed business up to its highest notch in order to enable those who remain at home to do their bit and help to pay the bills.

In addition to this feature, the labor which is usually employed in this character of work is not of great value in any other line on account of their having confined their efforts to this character of employment. Hence, if these public improvements should stop, these men would be out of a job and would be compelled to turn their attention to something else, where they would not be as efficient or of as much assistance in making business go strong as they are in the handling of public improvements.

Therefore, it occurs to me it is evident that this line of business should not be in any way neglected, but should be speeded up as much as possible.

Yours very truly,

THE HACKEDORN CONTRACTING COMPANY,
By HILLIS F. HACKEDORN, President.

Indianapolis, Ind.

The Editor of MUNICIPAL ENGINEERING:

Sir—

It is as inconceivable to a normal mind for public improvements to be stopped or hindered now, at this crisis, as it would appear preposterous to break down important bodily safeguards to health when a deadly disease is making attack upon the human system.

We need, doubly need, every advantage which the improvements themselves can confer. We need the activities which they engender in trades and business, and we needs must have, in a superlative degree, cool, calm judgment, a never-failing by-product of straight, strong, concentrated attention to legitimate business, of which few branches equal or excel constructive public improvements.

Many problems hard of solution confront us, but this is easy, for if infinity equals our productive and constructive power in time of peace, surely it must be raised to the nth power of efficiency to cope adequately with conditions which now assail us and which will be even more formidable to combat when our armies are disbanded. When the soldiers come back from victory, with no longer need for the high-tension strings of patriotism, what other force in the world can restimulate their relaxed energies like seeing and being brought into line with organized, steady labor which has never been discontinued or demoralized?

"Labor is life; 'tis the still water faileth." This is the best motto for all of our workers, our whole people, our country.

Respectfully yours,

FRANK M. DUVALL.

Annapolis, Md.

The Editor of MUNICIPAL ENGINEERING:

Sir—

I feel that all questions of patriotism or duty should be left entirely to the individual man, and that the best argument to be advanced for uninterrupted construction programs from the standpoint of purely economic logic is this: the improvements must be made. If we do not make them now, we shall have to do it later, because the expansion and the development of our municipalities demand them. Of course, it will be granted that the expense of the war's burden upon us will continue many years after the close of hostilities. From this we may well reason that we will then be in no better financial condition to make these necessary improvements than we are at the present time. Therefore, let us do it now while we are sure that we can bear the burden; and having done this, let us begin to reap the benefits at once.

Yours truly,

24 S. Seventh St., Philadelphia, Pa. R. L. KETCHAM.

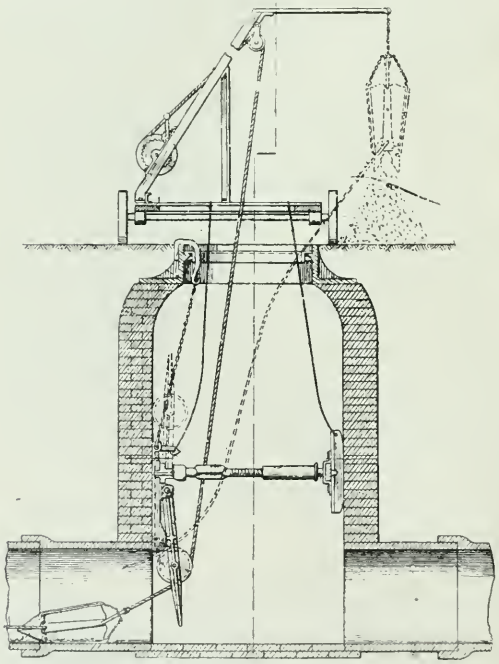
Plant Units and Lay Outs

Improved Sewer Cleaning Machine

The problem of sewer cleaning has been simplified to a considerable degree by the Kuhlman mechanical cleaner recently developed. In this machine the pull of the cable closes the jaws automatically, making a smooth job of cleaning.

Five buckets are provided for in the system, so that any sewer from 8 in. up may be cleaned. Roots and deposits of sand, etc., have been removed with the bucket rig.

Considerable advantage is claimed on account of the fact that the bucket need not be drawn from one manhole to another, but is only pulled into the sewer far enough to be filled with the deposit, at which point it is drawn back out of the same manhole in which it was inserted, since the bucket is so constructed that when the reverse pull is made, the jaws close tight and hold anything that may have entered the



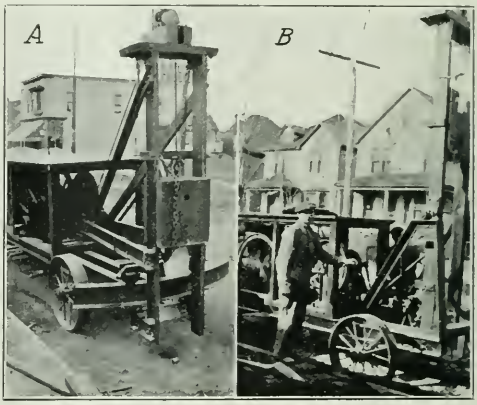
A REVERSIBLE SEWER CLEANING MACHINE.

bucket in its forward movement. Considerable time is saved when the deposit is near the manhole by reversing the pull to the shortest distance to the manhole. The trolley jack is so arranged that the buckets will slide up out of the sewer without the cable cutting into the sewer or the brick work.

For the operation of this system of sewer cleaning there are two steel trucks used, with hoist windlass and swinging loading boom; also two trolley jacks for guiding the cable and buckets in manhole. Two ⅜-in. wire cables 300 ft. long are utilized, with a 6-in., 8-in., 12-in. and 15-in. expansion bucket and a 10-ft. hand hook.

Concrete Breakers for Trench in Pavement

Two types of concrete breakers, for tearing up paving preparatory to excavating trenches of water, sewer and other pipe lines and conduits, are here illustrated. Both of these machines were designed and built by Raymond A. Mercier, superintendent for J. A. Mercier, general contractor, 216 Hammond building, Detroit, Mich. The information here given was furnished by J. H. McGinn, of this contracting organization.



MACHINES FOR BREAKING CONCRETE OVER TRENCHES.

Machine A is equipped with swinging leads and can be turned to break up a strip 6 ft. wide. The leads are 6-in. channels, 8 ft. 4 in. long, spaced 16 in. apart. The lower braces to leads are also 6-in. channels, with straps on one side for inserting the pole to guide the location of hammer blows. The upper braces are 4-in. channels. The hammer weighs 600 lbs. and measures 17x22x12 in., with ½-in. groove on either side to fit the leads. The swinging arc is an 8-in. I-beam of 6-ft. chord. The main body frame is of four 8-in. I-beams, 15 ft. long. The power is furnished by a 9-h.p. horizontal, water-cooled Foos gas engine, connected with flexible link chain drive to the countershaft. The countershaft is geared to an ordinary hoist clutch, which is equipped with a foot brake. A ½-in. cable from the clutch runs down under one 15-in. sheave wheel and over a second 15-in. sheave mounted on the pivoted end of the swinging leads. The third 15-in. sheave is at the head of the leads. The running gear consists of 36-in. iron wheels at the hammer end and 24-in. wheels at the engine end. An ordinary wagon tongue and eveners are provided for drawing the machine by horses from job to job. When in operation along the line of the trench, the machine is advanced by attaching a cable to the wagon tongue, passing it thru a pulley block fastened to an iron stake driven in the pavement some distance ahead of the machine, and back to an ordinary hand-operated windlass.

The wearing surface of the pavement is removed by hand before the breaking up of the concrete base is begun with the machine. The hammer has a removable wedge shape point, which is fitted with a two-way bolt hole, so the wedge edge

can be made either transverse or longitudinal to the line of the trench. Thus it can be used for cutting sheet asphalt to an accurate line.

Machine B is the same as machine A except for the leads. Machine B has stationary leads of 6-in., oak-lined, channel iron. They are 12 ft. long and are spaced 18 in. apart. The leads are supported on the main body frame by an A-frame, at either side, made of two 3-in. angles, back to back. The leads are pivoted on top of this A-frame so as to permit the leads to fold back and rest on top of the machine housing, when the machine is being moved from one job to another.

"Standardized" Meter Top

In a meter-box top which was recently placed on the market the ordinary round throat is replaced by one rectangular in section. This feature is said to greatly lower the cost of installation, as the bricks can be laid close up to the casting with a minimum of breaking and fitting.

STANDARDIZED METER TOP.

The new "Standardized" top is made especially for tile measuring 18 in. inside diameter. It is furnished either with or without an inner lid. Light weight is one of its notable features, a reinforcing rim extending around the edge of the casting, giving it added strength, while allowing the weight of the metal to be kept down.

A locking device is used which it is claimed eliminates any possibility of the cover being lost or stolen. A turn of the unlocking wrench releases the catch and also raises the cover a good half inch above its locked position. This effectively disposes of the frozen-cover question, without any necessity of chilled hands or battered fingers. As the locking device itself is a bronze casting, there is no possibility of corrosion.

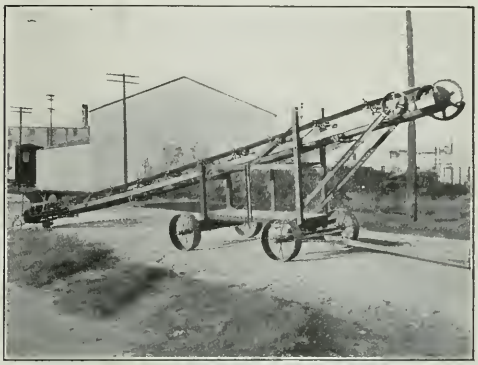
Portable Loading and Conveying Machine

That adherence to the old "horse and wagon" method of doing work involves considerable loss is once more proven, this time by a portable loader. It is claimed that the loader (which is operated by a 4-h.p. engine) does work equal to ten or more horses, depending on the character of the work. This economy is the direct result of the most efficient application of power.

The "E & S" portable loading and conveying machine is used for doing all kinds of excavating, and loading such materials as sand, gravel, crushed stone, coal, ore and dirt of all kinds. As illustrated, the rig is essentially a belt conveyor mounted on a truck in such a manner that the lift is easily adjustable. Load is put on the belt thru a hopper at the lower end, power being supplied thru a reduction gear to the pulley at the upper end of the conveyor. The engine is set directly on the truck platform.

In excavation work with the "E & S" there is a marked advantage, due to the fact that the machine itself is on the level, while the lower end of the conveyor extends into the basement and is automatically lowered as the excavation goes on. This feature makes it possible to load on the street level or at any required depth below the level of the street, in this way eliminating hauling loaded wagons up steep inclines or out of excavations, thus saving time, men, labor and horses, which, in all, is saving money.

This machine can be used to great advantage in the loading from stock piles of sand, gravel, crushed stone or coal to



PORTABLE LOADING AND CONVEYING MACHINE

wagons or flat cars. The machine is built almost entirely of steel, reinforced with wood. A special feature of the "E & S" conveyor is its dust-proof roller bearings, over which the belt moves. These are adjustable to any width of belt, and have a much longer life than the lower-priced cast-iron rollers.

A Pipe Line Street Flusher

Somewhat at variance with the ordinary idea of a portable water tank propelled by horses or gasoline, is the portable pipe line which has been developed by the Buffalo Municipal Equipment Company for use in flushing streets. While the pipe-line flusher is less rapid than the tank flusher, it is said to be more thoro, and will, it is claimed, entirely free the street of dirt. Pivot-mounted discharge nozzles are so fixed that they can be turned in a complete circle, flushing the street surface from curb to curb.

As the stream from any nozzle cleans well ahead of the next nozzle in line, the operator can work from one to the next, cleaning up thoroly as he goes along, and always working down hill if on a grade. At the last section of pipe in the line two swivel joints and nozzles are provided so that the operator can clean up a space at least equal to another section of pipe. For a 240-ft. stretch of pavement the cleaning time

PORTABLE PIPE LINE FLUSHING OUTFIT.

with the portable flusher is given as from 5 to 7 minutes.

It is claimed that the valve arrangement is very economical of water, as the operator has direct control of the stream at all times and shuts off the flow instantly with his wrench when desired. As the nozzles are set very low, the stream does not damage the pavement. This feature prevents washing away of sand and gravel during the flushing process.

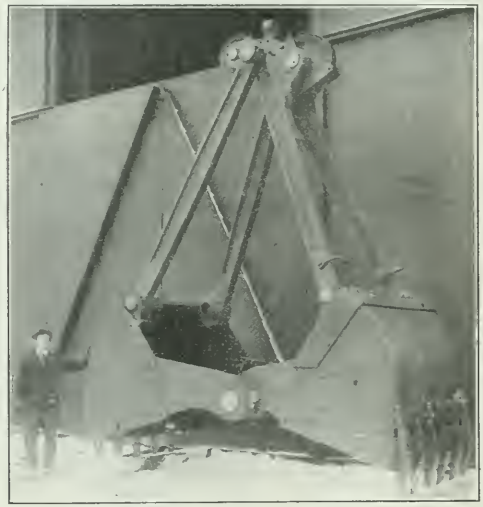
As shown in the accompanying illustration, all movements

of the nozzle are controlled by the operator with a long-handled wrench, which is the only equipment he needs to carry. The entire pipe line, being mounted on small wheels, can be moved as desired without disconnecting, and as all connections are flexible, can be taken around street corners and past obstacles. For long hauls the units are simply disconnected and loaded like ordinary pipe on a wagon or motor truck. Claim is made that the use of this apparatus has resulted in a considerable decrease in the cost of flushing city streets.

A Big Clam Shell Bucket

The Williams clam shell bucket here shown has a capacity of 10 yds., and weighs approximately 25,000 lbs. A forged steel hinge pin 9 in. in diameter holds the jaws together. Corner pins and sheave pins are each 6 in. in diameter. The high carbon lips are 1½ in. thick and the scoop plates 1¼ in. thick.

While no data are available as to the capacity of this giant



10-YARD CLAM SHELL BUCKET.

bucket in actual service, an estimate can be formed from figures showing work done by a 5-yd. bucket of the same design. On a levee project at Beardstown, Ill., a bucket of this size dug 167,000 yds. of clay in a month, and in eighteen working days handled 157,000 yds. of clay. Work was done by the Edw. Gillen Dock, Dredge and Construction Company.

The cables used to operate the 5-yd. bucket were 1½ in. for the hold line, which is equipped with a hurden block, the main weight being lifted with two parts of line. The closing line was 1½ in. on the straight lift, the drums being so arranged that one operated at twice the rope speed of the other.

An All-Year Truck Cab for the Contractor

As much often depends on the motor truck driver as on the truck itself, and the driver's comfort exerts a marked influence on his efficiency. For this reason contractors operating motor trucks will be interested in a new feature for Kissel trucks. It is a new adaptation of Kissel's original convertible idea, giving a closed cab for winter, which is easily changed to the Kissel standard open cab for summer use.

The cab is a little over 5 ft. high over all, and is substantially constructed of bolted hardwood frames covered with treated sheet metal. The dash is of heavy plated metal. The cab is sufficiently flexible to negotiate rough roads successfully. The seat accommodates three men, and the tank and tool compartments are under it. All the accessories are there in unsurpassed arrangement and completeness. Special Pittsburgh glass is furnished for the doors, sides and rear window, which has a heavy wire screen. There is a rain-vision windshield with the winter equipment.

This all-year cab is wind-proof, rain-proof, cold-proof—in a word, it is weather-proof the year round in any climate.

Portable Water Heater for Contractor

Herewith is illustrated a new portable water heater, which should be of particular interest to contractors. The outfit consists simply of a coil 100 ft. long of 1-in. water pipe, enclosed with a sheet metal salamander.

A fire built inside the salamander heats the water as it passes thru the coil, thus providing a steady stream of hot water. The value of this as an adjunct to cold weather concrete work is obvious.

Practically any burnable material can be used as fuel. The machine is open at the bottom, where the lower coil forms a grate for the burning material. The coil itself is held in place by two bars with lugs, which project between the pipes on opposite sides of the coil.

The machine weighs only about 300 lbs. and is easily portable. C. A. Londelius & Sons Co., Chicago, are marketing it.

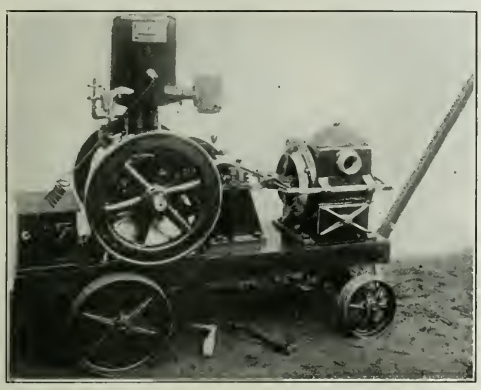
Among the well-known Chicago contractors now using the heater are Stressenreuter Brothers, 3020 South Halstead street, and the Please Concrete Construction Co., 805 Stock Exchange Building.

A Portable Gas Engine Pump

Reliability and portability are combined in the gas-engine-driven diaphragm pump shown in the accompanying illustration. This Novo Engine Company set consists of a vertical 4-cycle gas engine connected thru gearing and an eccentric to a double-acting diaphragm pump. As the diaphragms are

placed in vertical planes it is claimed that they are not so likely to be cut by the dirty, gritty water handled.

Being power-driven and working near capacity all the time, the pump has considerably more than twice the capacity of a single-acting hand-operated pump of the same size. Cost of operation is low, as the engine will operate continuously, it is claimed, on less than a quart of fuel per hour, handling in this time from 6,000 to 8,000 gal. of water.



PORTABLE GAS PUMPING UNIT.

As this pump has no plunger, and as a rubber diaphragm takes the place of a piston, there is nothing to be cut by sand or grit. A considerable saving is made on account of the fact that no attendant is necessary for the set. The pump can be started by any one who can give the wheel a good strong turn. The flapper valve can be replaced by the laborer in charge of the outfit.

The engine used is of the hopper-cooled type, the cooling water being poured in an open jacket surrounding the cylinder. Due to special design, it is said that the hopper and cylinder will resist coldest weather, both being guaranteed by the makers against cracking, even when the cooling water freezes solid.

Make-Up and Cost of Home-Made Portable Pump

An efficient portable centrifugal pump outfit designed to pump out flooded manholes was constructed a short time ago by the Lincoln Park commissioners, Chicago, under the direction of C. H. Shepard, electrical engineer. The pumping plant consists mainly of a 12-h.p., 1,500-r.p.m. gas engine (marine type), direct connected to a 500-gal.-per-minute centrifugal pump. These are mounted on an ordinary four-wheeled hand truck, together with radiator, gas tank and circulating system. For cooling, an ordinary automobile radiator is used.

With this improvised set a volume of 300 gal. per minute can be pumped against a 15-ft. total head.

All of the control apparatus is grouped together at one end of the machine, so that it can easily be reached by one man. Free access is obtained to all parts by a system of hinged removable walls.

These detailed figures given by Mr. Shepard show the actual cost of building this unit:

Cost of Building Emergency Pump Unit

MATERIAL

1 marine engine and muffler	$ 90.00
1 radiator	25.00
To build truck for engine pump and wheels	225.30
To install engine on pump truck	69.07
Painting pump truck	21.54
To supplying suction hose, valve and fittings	125.89
3 1¼-ft. valves	2.82
1 cap	.10
12 bolts, various sizes	.12
5 pipe plugs, various sizes	.36
5 bushings, various sizes	.45
12-ft. water pipe, various sizes	2.34
28 nipples, various sizes	2.24
4 tees, various sizes	.30
6 unions, various sizes	.99
56 screws and nuts, various sizes	1.00
19 ells, various sizes	1.61
6 padlocks, various sizes	6.60
Miscellaneous material	24.13
Total	$599.86

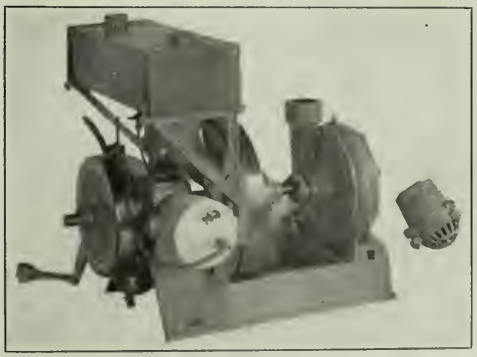
LABOR

Mechanic, 31 hours at 50c	$ 15.50
Helper, 104 hours at 32c	33.28
Total	$ 48.78
Garage expense (overhead)	120.85
Grand total	$769.49

A Compact Pumping Unit

The gas-engine-driven centrifugal pump here illustrated is a convenient piece of machinery for the contractor, both on account of its light weight, which permits easy moving, and

A HOME ASSEMBLED PORTABLE PUMP.



CONTRACTOR'S SMALL PUMPING UNIT.

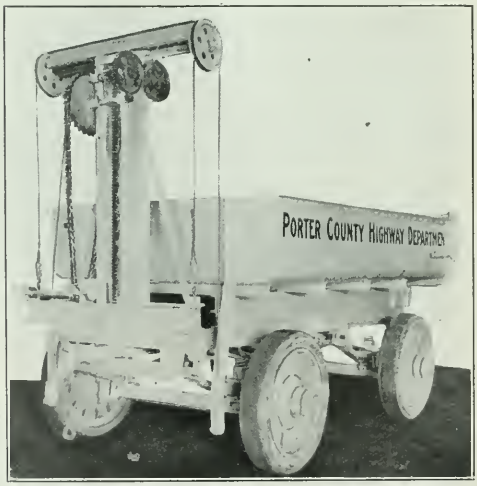
because it is really a "general purpose" set. As will be noted from the illustration, the engine is of the 2-cylinder type, with cylinders directly opposed. Use of air instead of water for cooling purposes gets around any danger of frost-cracked cylinder, that exists with the water-cooled engine.

When the pump of the set is not required, the removal of three screws disconnects the engine, leaving it free for another work. In the construction of the engine there are no cams or lubricating valves to get out of order, and the lubricating oil is put into the tank with the fuel oil.

The limit for lifting water with a centrifugal pump is about 25 ft., but the height to which it will force it is from 60 to 100 ft. The 3-h.p. unit delivers 125 gal. per minute at 30-ft. head, and the 5-h.p. unit delivers 250 gal. per minute at 30-ft. head. The 3-h.p. pump has a 2-in. suction and 2-in. discharge, with a weight of 160 lbs., while the 5-h.p. pump has a 3-in. suction and 2½-in. discharge, the weight being 250 lbs.

New End Dump Trailer

A new end dump trailer, for which claim of high efficiency is made, has been perfected and is finding a growing field in the haulage of construction materials. The end dump mechanically operated hoist and body, as illustrated, is known as the "Archer," and in the size shown is mounted on a 5-ton Troy



AN END DUMP HOIST AND BODY.

trailer. A novel feature of the hoist is the fact that one man can easily raise the body with its 5 tons of contents to an angle of 45 deg. in 2 minutes' time. Sand, stone, cement and other construction materials are thus handled easily. Owners of motor trucks and trailers claim that 75 per cent to 100 per cent more material can be hauled with a trailer thus fitted for quick dumping, with only a slight increase in cost of operation of truck.

Industrial Truck for Hauling Material

One ordinarily thinks of 3-yd. dump wagons or big 5-ton motor trucks when the subject of hauling bulky, loose materials is considered. However, the attached illustration shows a rig recently placed on the market, which, because of its extremely small size and simplicity and speed of operation, has made a place for itself with a number of up-to-date contractors.

The motive unit is an electric-driven industrial truck of 2-ton capacity, similar to those commonly used in warehouses and railroad stations for hauling trunks, boxes and miscellaneous supplies and heavy materials. Upon this truck is mounted a side-dumping hopper of 1½-yd. capacity. One of

A COMPACT HEAVY-HAULING UNIT.

the features of this patented machine, which differentiates it from the ordinary industrial car, is that the load is thrown out several feet away from the truck, as shown in the illustration.

Over-all dimensions of the complete machine are: Length, 8 ft.; width, 4 ft.; height, 4 ft. Hoppers dumping in a similar manner from the end of the truck are also manufactured.

A Water Ballast Roller

A water ballast roller has been devised by an English manufacturer to provide for rolling roads under varying pressures as required by differing operating conditions. The 12-ton oil tractor illustrated is provided with a 4-cylinder, 35-40-h.p. engine, and has a tank roller of sufficient capacity to increase the total weight to 14 tons.

A WATER BALLAST ROLLER.

The rear roller, as shown in the accompanying illustration, is made up of cast iron and is of heavy reinforced construction, to do its work as a drive wheel. Power is supplied by a moderate speed, water-cooled engine, the radiator being located over the rear roller, where its weight is most useful. Two speeds are provided, viz., one mile and three miles per hour, the speed change being made by control levers located within easy reach of the driver.

SALES ENGINEERING

Opportunities for Engineers in the Selling Field

By N. H. Jacobsen, Sales Engineer, Chicago

The engineering profession presents a very broad field of activity, the extent of which is not properly appreciated by those most vitally interested. The limits are very hard to define, because they are gradually being extended by the discovery, in various lines of effort, that the engineer possesses the best fundamental equipment to secure results in many lines. The development of engineering courses of study to their present high standard in our universities and colleges has been due, very largely, to a demand for specialized training, but as the results of this curriculum in other than highly specialized fields are being more fully understood and appreciated, the study of engineering is coming to be considered a fundamental—the best possible foundation for many kinds of work.

Many Engineers Get Side-tracked

With all its vast opportunities for success to the individual —success based on achievement of the highest order—there is something pitifully tragic about the engineering profession. The average engineer is the victim of the wrong idea. He has seriously and conscientiously set about thoroly to prepare himself, omitting none of the steps necessary to secure proper equipment. His technical training completed, he has attacked the problem of practical engineering with energy and enthusiasm and deserves to succeed.

Round Pegs in Square Holes

You engineers who embarked on your life work ten, fifteen, yes, twenty years ago, look back on the men who graduated with you—men who, with few exceptions, were alert, capable fellows. Some have achieved distinction, a large number have risen and are advancing but too many are standing still or going backward. A few would have failed at anything but most of them would not and should not. They are blindly devoting themselves to engineering as a highly specialized vocation, to engineering in the narrowest sense. Here lies the tragedy that, in spite of what bas been said and written about the opportunities for men with engineering training in that broader field of engineering, which overlaps other activities than technical work, men, without the proper temperment continue figuring stresses, designing or superintending construction, long after they have discovered that they are not suited for work of this nature. By virtue of hard work and the good qualities they possess, they may manage to overcome the fault of inaptitude sufficiently to hang on but they are not growing and, in the true sense of the word, they never will until they find the solution in work of a different nature. Their happiness depends upon their finding it. It is the duty of our universities, our societies and our engineering papers, without deprecating in the least the importance of technical work, to preach the gospel of "engineering the proper foundation for achievement in the business world."

Opportunities in Salesmanship for Engineers

Salesmanship is one of the important non-technical fields in which the engineer is making his mark. Here is a dignified calling where the opportunities are practically unlimited. The qualifications are hard to analyze but the transformation of the salesman from the agreeable individual who can talk but is not familiar with what he is discussing to the man in possession of definite, accurate information, is due very largely to the men with engineering training and experience who are taking up this work. They have been taught to persevere, to concentrate on every problem regardless of the difficulties until they arrive at the solution. Sales results are nothing more nor less than the solution of difficult problems. The important methods of attack which apply are the same as those which must be used in the consummation of a strictly technical achievement. There are, of course, questions of personality, of proper understanding of human nature etc., but the environment of the engineer is such that he should possess these qualifications to at least as great a degree as any one. If he does not, this and any other work offers to him the opportunity of success only to the extent that he is able to overcome his personal handicap.

Proper Selling Field for Engineers

Although the engineer need not necessarily restrict his efforts to any one branch of selling, it is only natural that his services are particularly valuable in the sale of materials, equipment etc., in the design or use of which engineering questions are involved. Even assuming that we consider this as defining the limits of the sales engineer's field of work, we will find that we have included a very large percentage of the things which are bought and sold.

And here the engineer is supreme. Ability intelligently to discuss a thing can come only from exact knowledge regarding it. Only the product of merit can survive and the extent to which it is used will depend upon two things i. e. how meritorious it is and how carefully and accurately its good points are explained to the prospective buyer. The accomplishment of the latter is the business of the salesman and the engineer has such a distinct advantage over the type of men who, until recently, have been devoting themselves to this work that he stands head and shoulders above them. Their only chance to reach the top or to stay there is by acquiring for themselves some of the things which the engineer already possesses and that is what the ordinary business man, engaged in the sale of what we may for convenience call "engineering products," has been forced to do in order to keep abreast of the times.

Engineers, Purchasing Agent and Salesman

Organizations which are large buyers find it necessary, in the interest of economy, to have their engineering and purchasing departments work hand in hand. An engineer prescribes what is to be bought and the successful proposal must have his approval before the deal is consummated. If the purchasing agent is a man with engineering training so much the better (and here I may incidentally hint at another field that is open to the engineer), but the important fact which I wish to bring out is that there is an engineer on the other side of the fence and the only man who is thoroughly competent to cope with the situation is the sales engineer. Often there is only one product which exactly meets the requirements and the sale is practically made before it reaches the purchasing agent. Our friend has been "on the job."

Selling Offers the Engineer Economic Salvation

The idea that his profession is narrow and that there are definitely defined limits beyond which he should not step, must be dispelled from the mind of the engineer. To the young man who is trying to make up his mind regarding the selection of a life work, who would like to take up engineering

but hesitates, let us say go ahead, you cannot make a mistake in this choice; to the graduate of our technical schools, who looks out upon the world and is discouraged because there seems to be no room for him, let us suggest that he look beyond the places where he must actually make use of the theoretical formulae he has mastered; and to the man engaged in a technical pursuit, who has long since gotten into a rut which is becoming deeper and deeper, the engineer who is fussing and fuming and worrying his life away because he is on the wrong road, let us advise that he risk the shock of pulling himself out of what, for him, is not the proper environment and of turning into any of the roads which point to success in the business world. If he knows how to be a man among men, let him take up sales engineering.

Salesmen You Ought to Know

This respectable middle-aged gentleman is not Theodore Roosevelt, but in his Rough Rider make-up he could easily impersonate the Colonel. He is a good fighter all right and for 20 years, as Eastern manager, fought for business for the Platt Iron Works. This veteran is George W. Neff, Hudson Terminal, New York City, New York. He recently changed to the John H. McGowan Co., makers of pumping machinery. He also handles all lines of power plant equipment. He covers

GEO. W. NEFF.

the New York and New Jersey territory and looks after the export trade. He is single only during the vacation season when he hies himself to Plainfield, N. J., to get away from subways and to find a place in the sun. The rest of the year he is married. He has one wife and one child. His hobby is vegetable gardening. Nothing foolish about this old boy—he already has a cellar full of potatoes and such like and can afford to let the heathen rage. His health is fine and his disposition has improved greatly since he gave away his gasoline buggy.

Smiling pleasantly, Mr. F. William Stocker appears on the reader's left. He is shown seated in his Stutz car and is "just after" scaring his passenger half doty with a burst of speed. He was after a big order and got it. F. William, as you doubtless know, is president of F. William Stocker, Inc., engineers, Hoboken, N. J. They deal in concrete specialties, metal forms, motor trucks, water-proofing, damp-proofing, curb-bars, paving joint and road mesh. Among the lines he represents are: United States Motor Trucks, Pittsburgh Paving Joint and Hotchkiss Metal Forms. He covers New York and New Jersey. Mr. Stocker, his cheerful appearance to the

F. WM. STOCKER.

contrary notwithstanding, is marriied, and that isn't all—he has three kiddies. He is a hunting sport and spends some time in the Adirondacks each summer, hunting game, scenery and action. He is one salesman who never Sundays at home. He is fond of the Waldorf Astoria and of the screen stars. He admits a preferance for Theda Bara.

This mysterious picture was snapped in Guatemala. It shows a monument of unknown antiquity and R. C. Tillinghast, also a holdover from former times. Mr. Tillinghast admits that he lives at 256 Broadway, New York. He has been representing Watson Tractor Trucks, Tractors, trailers and dump wagons ever since Joe Walker first built state roads. He covers Eastern New York, Northern New Jersey and New England. Each year, after Thanksgiving Day, he

R. C. TILLINGHAST.

takes his wife to Central America or the West Indies. But more about the monument—all savants save Mr. Tillinghast have failed to decipher the inscription. He quickly saw that it was an unsolicited testimonial which had never reached him. The portrait of the contractor who furnished the testimonial appears on what he used as a letter head. It may be this man was Superintendent of Public Works. However that may be, he was a sport and was there with the pitching chisel.

Digest of the Essential News

Municipal Engineering Takes Larger Quarters

In line with a general policy of expansion, effective in all departments, Municipal Engineering has removed from 608 South Dearborn street to the Rand-McNally building, 538 South Clark street, Chicago, where larger quarters have been leased. Friends of the paper are invited to make this office their headquarters when in Chicago.

Lakes to Gulf Waterway Project

Perhaps no engineering project in recent years, with the exception of the Panama canal, has so fired the imagination of the engineer as the Lakes to the Gulf waterway project, involving the construction of a ship canal across Illinois to connect Lake Michigan and the Mississippi river. All the plans discussed in connection with this project contemplate, of course, the utilization of existing water ways along the route of the canal.

Former Governor Dunne, of Illinois, was a strong advocate of this project, and it was something of an issue in the latest gubernatorial contest in Illinois. Many felt that Governor Lowden would not be favorable to the waterway project, and this caused many engineers to support the candidacy of Mr. Dunne.

Governor Lowden is making a brilliant, constructive record, and it should, therefore, occasion no surprise to learn that his administration is favorable to the construction of the ship canal. Leslie D. Puterbangh, director of the Illinois State Department of Public Works and Buildings, recently gave out an interview to Chicago newspapers announcing this fact.

The editor has just had a letter from William L. Sackett, superintendent of the Division of Waterways, indicating that the department will have a definite deep-waterways plan formulated in a short time. The Lowden administration has shown such marked ability to get results that engineers, contractors and others interested may feel confident that this project will get beyond the conversational stage before long.

Present Status of the Imhoff Tank Patents in This Country

The following statement has been issued by the Pacific Flush Tank Company, of Chicago, relative to the present status of the Imhoff sewage settling tank patents in this country and the payment of royalties for the use of these tanks:

Since the introduction in 1911 of the Imhoff tank for sewage treatment in the United States, we have been the commercial representatives for Dr. Karl Imhoff in the matter of collecting royalties under his patents and in the distribution of literature, etc., relative to such patents.

Our relations with Dr. Imhoff since their inception have been very friendly, but the present war has placed us in a somewhat embarrassing position, which, it seems to us, calls for an explanation to those interested.

The war with Germany prevents us from remitting further royalties to, or in any way communicating with Dr. Imhoff, who has become an alien enemy. This being the case, we have asked our Chicago attorneys, Messrs. Mayer, Meyer, Austrian & Platt, for an opinion as to the proper course to pursue in handling the matter until Dr. Imhoff, or his heirs and assigns, can be legally communicated with.

While the law forbids communication with an alien enemy during the war, it probably will not abrogate the ultimate rights of such alien enemy, and although we cannot at present transmit royalty fees to Dr. Imhoff, his right after the war to collect such royalties will in all probability be the same as if the war had not existed.

In order to protect those who are using or may in the future use the Imhoff tank for sewage treatment, we have decided to deposit with the First Trust and Savings Bank of Chicago in a special trust fund all moneys received by us for account of Dr. Imhoff after date. This fund will remain in trust until commercial relations with Germany may be legally resumed. For funds so paid we shall furnish a receipt and a certificate from the above named bank that said funds have been deposited with it in trust. In cases where no license has as yet been furnished by Dr. Imhoff, these funds received by us since the President's proclamation will be held in trust by the bank until such a license has been received from him, his heirs or assigns, or until otherwise disposed of legally.

We submit the foregoing explanation of our position to those who contemplate building or who have let contracts for Imhoff tanks, or who have already completed the construction but have not paid a license fee. The following table shows the royalty fees as heretofore prescribed by Dr. Imhoff, said fees being based upon the population ultimately to be served:

ROYALTY FEES ON IMHOFF TANKS

Pop.	Fee min.	Pop.	Fee	Pop.	Fee
100	$ 10	2,500	$155	15,000	$ 590
200	20	3,000	180	20,000	750
300	30	3,500	200	25,000	850
400	40	4,000	220	30,000	1,000
500	50	4,500	235	40,000	1,300
600	58	5,000	255	50,000	1,500
750	65	6,000	290	75,000	2,100
1,000	80	7,000	325	100,000	2,550
1,500	105	8,000	360	200,000	4,300
2,000	130	10,000	430	350,000	6,800

Our plan, we believe, will enable contractors to complete their contracts, pay royalties, and secure their release, and at the same time protect all cities or others desirous of using the Imhoff tank. In this connection we wish it distinctly understood that in suggesting this plan we assume no personal liability or responsibility other than herein disclosed.

The patents held by Dr. Imhoff and the date of their issue are as follows: June 5, 1909—No. 924,666; Dec. 20, 1910—No. 978,889; Feb. 18, 1913—No. 1,053,396; March 25, 1913—No. 1,056,548; March 25, 1913—No. 1,057,154.

Good Roads Notes

The county commissioners of Tillman county, Oklahoma, have appointed the county engineer as county manager, putting the road and bridge work of the county in his charge, acting under the general direction of the county commissioners in matters of policy.

In Nova Scotia, where it has been quite difficult to obtain labor of late, it has been found that this difficulty in the way of highway construction can be overcome in a measure by a wider use of road machinery, particularly graders. The pro-

vincial road commissioner, Hiram Donkin, is making a specialty of instructing men in the use of such equipment, in order that the full benefit of machinery may be obtained in every part of the province. The conditions on many of the Nova Scotia roads are such that roadbuilders accustomed to working graders in light to medium soil only, would be afraid to use them in the heavy soil of many parts of the province. It has been found, however, that by first using a road plow to loosen roots of bushes, boulders and hardpan, the road grader can finish the work easily and the total cost will be less than that of grading and ditching by hand and light tools, at the present wages for labor.

Progress in Sewage Disposal in Philadelphia

The officials of the city of Philadelphia have been giving very exhaustive study to the problem of sewage disposal since 1907. It will be remembered by our readers that in 1915 the Bureau of Surveys issued a report recommending a comprehensive plan for the collection, treatment and disposal of the sewage of the entire city.

In the summer of 1915 councils appropriated $500,000 to begin this project, and in the summer of 1916, in the $115,000,000 loan bill, appropriated $3,200,000 toward sewage disposal.

In accordance with the recommendations in the report, this money is being spent in the northeast division of the city, where the interception and treatment of the sewage will accomplish the greatest good by protecting from sewage pollution the source of the water supply of the city and also in restoring to a clean condition the grossly polluted Frankford Creek.

About 2¾ miles of the large Frankford Creek intercepting sewer and a grit chamber are under construction; land has been acquired for the sites of the northeast and southwest sewage treatment works, and a contract for $1,025,000 has been awarded for the construction of 32 horizontal-flow rectangular reinforced concrete two-story sedimentation tanks, with their appurtenant sludge drying beds—the first increment of the northeast sewage treatment works.

Lights and Shades

Smokes For You

Of course you smoke—well then, listen. Good stories are wanted for this department—stories of the construction camp, of the drafting room, of the engineering classroom, and of everything else in which engineers and contractors figure. You know the kind—polite but not necessarily lady-like accounts of funny things seen, heard or experienced in the day's work. Wait a minute, we're coming to that. You have all got good stories wrapped up in your systems—here is a chance to elaborate them. Now here it is: For the best story received for publication before Christmas we will give a five-dollar box of cigars or the same value in eating tobacco, at the winner's option. The winner will be picked in a staff conference. In case everybody disagrees with the editor it is expressly understood the editor's choice wins. Moral: Be good to the editor.

Gumshoe Bill Doesn't Like Our George

General Goethals and his Panama canal are regarded without enthusiasm, it seems, by Senator Stone of Missouri. Said the senator: "I have never been, I am frank to say, a very enthusiastic admirer of General Goethals. I barely know him. I do not recall ever meeting him more than once, but I am somewhat familiar with his career, and for one I venture to say, which I would not have done except in the immediate circumstances, that he is rather a pampered hero, whose reputation, such as it is, has been built largely upon the genius of other men. I go further and say that with the combined genius of them all, with the genius and intelligence of them all, the Panama canal lacks a vast deal of being a great engineering success. I regard it rather as a failure. I express that as my opinion." Some opinion.

Assertion Versus Argument

Don't give 'em too much to think and talk about—if you do they will talk themselves out and kill the project. In making reports where the comparative merits of several projects are discussed engineers should remember this. Soft pedal all the projects except the one recommended. Don't argue too much—make assertions instead. Watch T. R.—he knows how! Ever know him to state two sides of a case? He begins with a strong assertion and supports it with a series of assertions, each stronger than the one before. Let the people rule, yes, but make it impossible for them to blunder. Leave them just one choice and make sure that is the right one. Recognize the impotence of the wind blown away in popular discussions of engineering projects. This wind, by the way, blows away many fees, first and last.

Consider the Catenary

Exhumed from a mathematical treatise: "And so, no force, however great, can stretch a cord, however fine, into a horizontal line which shall be absolutely straight." Do you get the rhythm?

Architects, Too, Have Their Troubles

A newspaper writer quotes a Chicago architect as saying that when a window sticks in a new house the owner calls up his architect, about 2 a. m., to say that the house is a great disappointment and that he is sorry he had it built.

Definition

Said a prominent English jurist: "There are three kinds of liars, namely, liars, liars with a condemnatory adjective, and my brother William, who is an appraisal engineer."

Listen to Jim Hill's Son

Scoring the business slacker, Louis W. Hill of the Great Northern Railroad said: "The manufacturer or merchandiser who lays down at this moment—the commercial crepe hanger—is quite as definitely a non-patriot as the man who refuses to fight."

Origin of "Graft"

Those who claim to know say that the word graft was first used in the United States in connection with a small canal construction job, in New York, about 250 years ago. "Graft" was, and for all we know still is, the Dutch word for canal. Three laborers did the digging and a paid committee of five men watched the work to see that the laborers earned their wages. Now you know.

Study Engineering, Says Chicago Tribune

This editorial recently appeared in the Chicago Tribune, "The World's Greatest Newspaper:"

"Hardly more than half the usual number of young Americans are now enrolled as students of engineering, whereas there should be twice the usual number, for the larger part of the civilized world will have to be reconstructed after the war. Industrial plants, bridges, railroads are going to rack and ruin even when they escape destruction. War overworks them and prevents repair. If the war lasts two years even America will have felt the strain. The demand for engineers will greatly exceed the supply.

"We shall be unable to import them. When war broke out practically all the engineering schools abroad shut down, and engineers in Europe have since been slaughtered wholesale. Instead of our relying on Europe, Europe hopes to rely on us. As things look at present, it is a forlorn hope.

"The Society for the Promotion of Engineering Education recently went over the whole question at its meeting in Washington. Several remedies are suggested. One would discourage enlistment among students of engineering. Another would put those who are drafted in the engineering corps. Still another would provide government aid for young men willing to enter a technical school. The more practical suggestion and the one easiest to apply is the call for proselyting. Tell every boy of your acquaintance that engineering will be the best paid profession for at least ten years after the war. That is the truth. Make him see it. Any lad with the requisite gifts will find the technical school an open door to success and prosperity and incalculable usefulness."

"Engineering will be the best paid profession for at least ten years after the war." Perhaps. Before engineers become well paid they must get over bowing and scraping and saying, "Thank you, sir!" when they are handed a one dollar fee for a five dollar service.

A Practical Suggestion

Clancy, the paving contractor, had dug deep and often for the new church. At length it was built and furnished from basement to belfry except for the church bell itself. A meeting of the angels was called to raise funds for the bell. Clancy's turn came. He said: "We've a fine church with fine pews and a fine pulpit. We have a fine steam heatin' plant, too, so I move you that we can this bell idea and put a whistle on the church!"

Stephenson's Early Difficulties

In his boyhood George Stephenson herded cattle and drove a ginhorse in a coal mine for six pence a day. Not until his eighteenth birthday was he able to read! For fifteen years he worked unceasingly on what many people called a dream, but success came finally on Sept. 27, 1825, when he opened the first railway over which freight and passengers were hauled by a locomotive. He had great native ability, yes, but he also had great perseverance.

FIRE ENGINEERING

The "Two-Platoon System" in Chicago

Marked difference of opinion still exists among Chicago authorities as to the success of the two-platoon system in actual practice. As a means of checking up the men available under the two systems, a careful count was made of the men at the first fire after the passing of the two-platoon ordinance, this figure being compared with an authoritative estimate of the men who would have been on the job under former conditions.

Claims made by Geo. B. Horgan, president of the Fireman's Association of Chicago, show that sixty-six men were present at the fire, while under the old method there would have been only sixty-five.

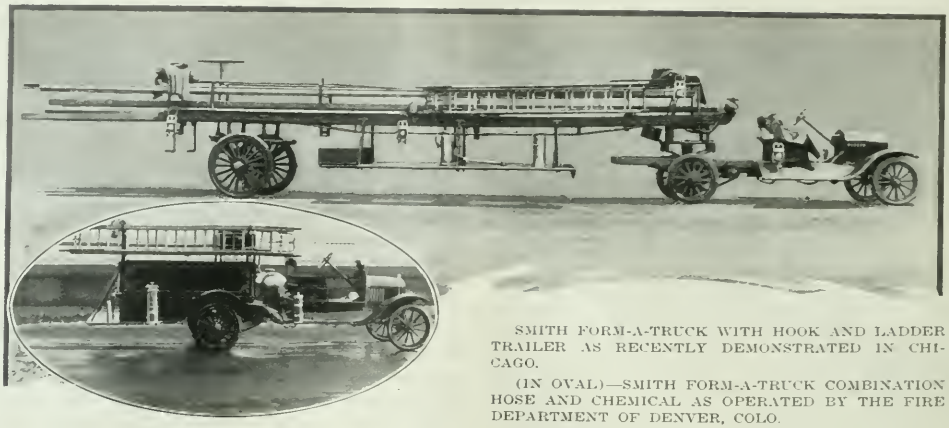
According to the statements of the officers of various companies which responded to this first call, the number of men at the fire was sixty-two instead of sixty-five, and under the old arrangement would have been seventy-three instead of sixty-five, as stated by the supporters of the system formerly in vogue.

In presenting both sides of the question, a table was made up showing the figures as given by the Fireman's Association and the company officers. The last column gives the additional number of officers that would (under the old system) have been available had the fire occurred at 9 p. m. or later, after these men had returned from theater detail. The table follows:

	New system		Old system		9 p. m.
Co.	Ass'n	Officers	Ass'n	Officers	Officers
20	6	5	5	6	7
30	6	6	6	6	8
35	6	6	6	6	8
111	5	5	5	5	7
26	6	7	6	7	8
33	6	5	6	7	8
43	6	5	6	7	8
57	6	5	6	6	7
19	7	6	7	7	8
28	6	6	6	8	9
Sq.	6	6	6	8	8
Total	66	62	65	73	86

Lafayette Buys Fire Truck

The South Bend Motor Car Works recently delivered to West Lafayette, Ind., one of their type PC11-97-6, 500-gallon Hoosier pumps. Before acceptance this pump was put thru two underwriters, both of which it passed with flying colors. The first test for 1½ hours full capacity delivering 550 gallons per minute at 120 lbs. pump pressure through two 50-ft. lines siamesed into one 1⅜-inch nozzle. In the second



SMITH FORM-A-TRUCK WITH HOOK AND LADDER TRAILER AS RECENTLY DEMONSTRATED IN CHICAGO.

(IN OVAL)—SMITH FORM-A-TRUCK COMBINATION HOSE AND CHEMICAL AS OPERATED BY THE FIRE DEPARTMENT OF DENVER, COLO.

test, (1 hour) 340 gallons per minute, were delivered through one 100-ft. line with 1-in. nozzle, at 200 lbs. pump pressure.

This same car was driven to St. Joseph, Mich., to the Michigan State Fireman's Convention and several demonstrations were given for the benefit of the Michigan chiefs.

Before this car was accepted and before going through the underwriters' test at West Lafayette, an alarm was given from Kirkpatrick, Ind., a distance of 27 miles and this car was sent over by the delivery engineer in forty-five minutes. It was "on the job" for four hours, working to such good advantage that it prevented the destruction of several buildings and grain elevator.

Other recent deliveries made by the South Bend Company are one type CH-60 and one type CH-40 combination wagons to the City of New York and two type CH-40 combination wagons to Weehawken, N. J. Among the recent contracts are six type H-60 hose wagons and one type 40 tool car to Cleveland, Ohio, one type CH-40 to Coldwater, Mich., one type PCH-140-6 to Kendallville, Ind., two type PCH-95-4 350 Gallon Hoosier Pumps to Muncie, Ind., one type PCH-97-6 500-gallon Hoosier Pump to Oxford, Pa., one type CH-60 to Newburgh, N. Y., three type S-120-6 Squad cars to Newark, N. J., and one type CH-95-4 Combination Car to Gary, Ind.

A New "Ford" Firefighter

A new piece of motor fire apparatus which is built on the standard Ford chassis has recently been placed on the market by its manufacturers.

This machine, which is a product of the Buckeye Manufacturing Co., combines in one piece of apparatus the advantages of a gasoline pumping fire engine and a first-class chemical equipment; carries a small ladder equipment and is arranged to draw the hose reel or hook and ladder truck behind it as a trailer on the smaller model. The machine is also built with a hose body. This makes a complete triple combination outfit.

As a water-throwing engine its capacity is 200 to 250 gallons per minute, and it will throw three streams of water 80 to 100 feet high in still air and 130 to 140 feet horizontally, pumping from open water, such as a cistern or pond. Where the town has a water works system and the pressure is too weak to do good service on a long line of hose, it will attach to any hydrant and add 80 to 100 pounds pressure to the stream, giving a strong and efficient stream where the water pressure alone is too low to be effective, thus enabling a town to get good fire pressure from an inexpensive low pressure water system.

As a chemical engine high efficiency is claimed for it. It gets its pressure from the motor and pump, and so has no pressure in the tank at all, hence the tank can be opened at any time and water and chemical added. Thus the supply can be renewed and kept up continually without ever stopping the stream, and the pressure is always very strong and unvarying. As there is a constant strong stream from the bypass back into the tank, the chemical is always thoroly agitated and mixed and at its maximum efficiency.

It has a speed of 25 to 30 miles per hour, and gets to the fire so quickly that probably nine out of every ten fires could be extinguished with the constant chemical with no water damage whatever to the structure.

If the water is inaccessible to the fire from the water mains it will take water from any stream, well or cistern and throw six to eight barrels per minute 100 feet high, or it will boost a weak, ineffective hydrant stream 100 pounds or more and make it strong, penetrating and effective.

The use of corrosive acid is entirely avoided in this chemical engine. This acid, used in other types of chemical, has proven dangerous for amateurs to handle under excitement and is destructive to the equipment itself; but the use of this acid is entirely eliminated by the new machine. There has been some effort made in the past to mount chemical tanks on the Ford chassis, but when sufficient chemical capacity is obtained the weight of the apparatus makes an overload for the car, while with the Howe-Ford apparatus 200 to 250 gallons capacity, such as is not possible with any other system, is obtained without overloading.

While the two machines thus described; namely, the model C, which carries the discharge hose in a trailer or hose reel, and the model H, which is a triple combination outfit and incorporates in the machine itself the hose body, proves so valuable to the small town it is relatively as valuable to larger towns for this reason. It is often the case in towns where they buy apparatus, of say from 700 to 1,200 gallons per minute capacity, that in attaching to the water mains the apparatus would have the capacity of pumping the water, but the mains do not have the capacity for delivering it thru a single pipe line. In this case four or five of these smaller machines can be purchased at about the same initial cost as the larger machine, and the same capacity is obtained. The smaller machine can be attached to separate hydrants, and it will be seen that the hydrants will not be "pumped dry" by one of these engines, and that more than 1,000 gallons can be supplied by all of these machines without danger of running out of water because it could not be supplied by one pipe line.

With these smaller units the chance of a breakdown is practically eliminated, as a single unit could be out of com-

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mission without any very serious results, while if the single machine, from any cause, should fail to operate, the fire might cause a total loss of the property before it was possible to get the single unit in operation.

The Howe-Ford carries complete equipment, including 150 feet of chemical hose, lanterns, hand fire extingulsher, fire axe, crowbar, spanners, wrenches, and such other accessories as are necessary.

PERSONAL ITEMS

Frank Koester, consulting engineer and city planning expert, Hudson Terminal building, New York City, has been retained by the City Planning Commission of Allentown, Pa., to prepare street plans for the site of an 8-mile railroad to be built by the Lehigh & New England Railroad Company, of Bethlehem, to avoid dangerous and costly grade crossings. This railroad, to be used exclusively for industrial developments, lies within the jurisdiction of the City Planning Commission of Allentown, for which Mr. Koester a year ago prepared a comprehensive city planning report.

O. Lourgaard has been appointed city engineer of Portland, Ore., to succeed Philip H. Dater, who resigned after holding the office for years.

Andrew T. Hansen, formerly chief deputy city engineer of Los Angeles, Cal., has been appointed city engineer, to succeed Homer Hamlin, who had held the position since August, 1906. Mr. Hamlin was removed from office by the Board of Public Works, following disagreements relative to reports on paving work, in which his recommendations were contrary to the views held by the board. In connection with this action the board paid a high tribute to Mr. Hamlin for the valuable services he has rendered the city in past years.

Philip Guise has been appointed county engineer of Sussex county, New Jersey, to succeed Harvey Snook. He will also serve as city engineer of Newton, N. J.

W. H. Ellis has been appointed commissioner of public works of Butte, Mont., to succeed Edward G. Kane, who resigned. Mr. Ellis was formerly assistant city engineer of Anaconda, Mont.

C. C. Cottrell, formerly on the engineering staff of the California Highway Commission, has been appointed assistant highway engineer of the State of Nevada.

The Barney-Hocke-Ahlers Construction Corporation, with offices at 110 West Fortieth street, New York City, has been formed to engage in water front and concrete construction. The members of the firm are all experienced engineers and contractors.

C. E. Henderson, formerly city engineer of St. Augustine, Fla., has resigned to become county engineer of St. Johns county, with headquarters at St. Augustine.

John F. Hayford, dean of engineering at Northwestern University, Evanston, Ill., is in Washington, serving as a member of the National Advisory Committee on Aeronautics.

James M. Barker, professor of civil engineering in the Massachusetts Institute of Technology, Boston, Mass., has been appointed consulting bridge engineer for the Massachusetts Public Service Commission.

William F. Moore, formerly city engineer of Grand Rapids, Mich., has been appointed state highway engineer for Indiana. He was city engineer of Grand Rapids for over two years, going there from South Bend, Ind., where he had been city engineer for six years. He was at one time city engineer of Mishawaka, Ind., and years ago was in the contracting business.

M. P. Paret has opened a consulting engineering office at Lake Charles, La. He was formerly on the engineering staff of the Interstate Commerce Commission.

William Smith has been appointed city engineer of Jackson, Ky., to succeed Henry Dennen, who resigned the position because of bad health.

George Wells, with headquarters at Pikesville, Ky., has been appointed county engineer of highways for Pike county.

Francis F. Longley, for years a member of the firm of Hazen & Whipple, consulting engineers, New York City, has been given a major's commission and sent to France, where he will take charge of all water supply engineering required by the American army in France. In going back to military service he is going home, for he is a West Point graduate of the class of 1902. He has had a varied experience in water engineering.

J. H. Prior has resigned his position as chief engineer of the Illinois Public Utilities Commission to open an office as consulting engineer in Chicago.

Le Roy K. Sherman, well known in the Middle West for his work on the engineering staffs of public commissions, has opened a consulting engineer's office at 137 South La Salle street, Chicago. He will specialize in water engineering, land drainage, sewage treatment and public utility valuation. He was formerly engineer member of the Illinois River and Lakes Commission. Prior to that time he was assistant chief engineer of the sanitary district ot Chicago, and built the widely-known hydro-electric plant of the district at Lockport, Ill.

Capt. Paul Hansen, of the Engineer Officers' Reserve Corps, formerly chief engineer of the Ohio, Kentucky and Illinois State Boards of Health, and at one time engineer of the Illinois State Water Survey, has been ordered to report for active duty with General Pershing's army in France. Every good wish accompanies this kindly, talented, public-spirited man.

COMING CONVENTIONS

LEAGUE OF AMERICAN MUNICIPALITIES—Annual convention at Gary, Ind., Sept. 5-8. Sec'y, Robert E. Lee, City Hall, Baltimore, Md.

NEW ENGLAND WATER WORKS ASSOCIATION—Annual convention at Hartford, Conn., Sept. 11-14. Sec'y, Willard Kent, 715 Tremont Temple, Boston, Mass.

LEAGUE OF IOWA MUNICIPALITIES—Annual convention at Iowa City, Sept. 18-20.

LEAGUE OF CALIFORNIA MUNICIPALITIES—Annual convention at Santa Rosa, Cal., Sept. 24-29. Sec'y, Wm. J. Locke, Pacific Bldg., San Francisco.

NATIONAL ASSOCIATION OF PURCHASING AGENTS—Annual congress at Pittsburgh, Pa., Oct. 9-11. Permanent headquarters, 600 Westinghouse Bldg., Pittsburgh.

LEAGUE OF MINNESOTA MUNICIPALITIES—Annual convention at St. Cloud, Oct. 17-18. Sec'y, Richard R. Price, Univ. of Minnesota, Minneapolis.

CITY MANAGERS' ASSOCIATION—Annual meeting at Detroit, Nov. 19-24. Sec'y, W. L. Miller, City Manager, St. Augustine, Fla.

FIRST CHICAGO CEMENT MACHINERY AND BUILDING MATERIAL SHOW—Supersedes annual Chicago Cement Show. To be held under auspices of the National Exhibition Co., 123 W. Madison St., at the Coliseum, Feb. 6-13, 1918.

Vol. LIII. — No. 4. Municipal Engineering October, 1917.

Design, Construction, Operation and Maintenance of all Public Works

CURSE OF THE CONTRACTING BUSINESS

The contracting business is sorely afflicted with a custom. This custom is a blight, a killing frost, a curse. In parliamentary language this troublesome agency is called the low bid. The low bid is one of our cherished institutions. It is lovely in theory. In practice it is as a monkey wrench hurled into the machinery of construction. Everything would be lovely if it were not for the fact that a fool is born every minute and that an amazing number of them horn into the contracting business. Knowing nothing whatsoever about costs they keep bidding until they are decidedly low on some job. Owing to the prevailing willingness of city officials to sting the contractor on occasion, the ridiculously low bidder is awarded the job. Lacking experience and an organization he is soon head over heels in a dozen kinds of grief. He throws up the job or stays on and goes broke. This makes for poor construction, delays completion, increases costs and balls things up generally. Meanwhile the responsible bidders are looking for other jobs, occasionally winning out, of course, at a fair price, but being often thwarted by the irresponsible low bidder. There is generally at least one such bidder at every letting.

Isn't it about time for engineers to come to the rescue of contractors in this connection? For humane reasons why not save the irresponsible bidder from his ignorance and folly? He is a good man, as often as not, but is out of his element. With credit at the bank and an inclination towards contracting, and a desire to win the supposedly large profits in the business, he takes a flier in the construction business and speedily goes broke. Let engineers warn their employers against the irresponsible bidder. Let engineers explain that it never pays to underpay a contractor. The owner invariably suffers when an attempt is made to gouge the contractor, especially a contractor who is incompetent, inexperienced and not any too strong financially.

TO SAVE MONEY BUILD NOW

There is a disposition in some quarters to postpone constructional activities until after peace has been restored. Undoubtedly this tendency rests upon the assumption that with the return of peace there will be an immediate return to ante-bellum conditions with reference to the cost of labor and material. We are convinced that this view is fallacious, for the specific reasons here set forth. At the outset too much emphasis cannot be placed upon the fact that considerations of narrow self-interest quite as much as those of broad and enlightened self-interest, commonly called patriotism, indicate the desirability of going on with building now.

Not only should plans be laid for a full program of construction next season but the present construction season should be continued as long as the weather will permit. From present indications conditions affecting the prospective builder are less onerous now than they are likely to be next year.

The United States seems definitely embarked upon a program of uplifting and upbuilding the world. This program has the approval of the vast majority of the people and of the leading political parties; therefore it is likely to remain in effect indefinitely. This will mean a greater demand for American labor of all sorts, at home and abroad, and a correspondingly greater demand for materials than the country has previously known. This greater demand for labor and material will continue after the war and will work greater hardship on the individual buyer then than now, for price regulation is likely to end with the war.

Scarcely a day passes but we are reminded of great building operations contemplated for Russia, France, Belgium and Poland at the close of the war. American engineers and contractors and American materials will figure heavily in these titanic labors of new and reconstruction. It is evident that this will boost prices in this country. In China and South America materials and men from this country will shortly be in greater demand than ever before.

In a previous issue we pointed out the various conditions which will continue to make for a labor shortage for an indefinite period.

Economists, generally, believe that there will be no drop in costs of labor and material for years following the end of the war. The restoration of destroyed merchant shipping and the upbuilding of the great American mercantile marine will impose heavy demands on labor and material alike. Coincident with and because of the expansion of foreign trade there will also come increased domestic demands for labor and materials.

American railways have been curtailing construction of all sorts for years and must soon engage in heavy building programs, however desirable inaction in this line may be as a background for demanding rate increases, war has taught us more of the economic and military importance of improved roads than we knew before, so road building is likely to go forward on an ever increasing scale. There is strong probability also of a partial return to water transportation which will call for new canals and much stream improvement.

We must revise our ideas relative to costs. We must become reconciled to higher labor and material costs. Those in the American public works field might conceivably stop building but the demand for construction materials and labor from other quarters would continue and would keep prices up so that when public works construction was resumed prices would be higher than when it was discontinued. Moreover, postponement cannot be continued indefinitely and depreciation is going on all the time. There is nothing to be gained by waiting to see now and when the war will turn out before going on with public works construction. On the other hand, there is much money to be saved by going on with vigorous construction programs now.

GET A FRESH START NOW

For fully fifteen years engineers have considered their profession overcrowded and have severely criticised the officers of engineering schools for advertising that engineers were in demand. Now all is changed. Employers of engineers state that it is hard to get men, and engineers are urging the schools to go out after all the engineering students they can get. Opportunity has again become the engineer's middle name. Now it so happens that during the aforementioned fifteen years we have heard a lot about square pegs in round holes—about misfit engineers. Isn't this the best time ever for the engineer to recast his business affairs a little nearer to his heart's desire?

CARELESS BIDDING

The beneficient Providence that is said to watch over the destinies of fools doesn't always protect the contractor who forgets to add the cost of material to the cost of labor in determining the amount of his bid. Occasionally, perhaps usually, a contractor who submits a ridiculously low bid is let off comparatively easy as a result of a frank confession of error. But if the body who receives the bid has no more Christian charity than George Peck's well-known tannery, the contractor finds he has let himself in for a lot of trouble.

Several cases of careless bidding have recently been reported. The board of public works of a large western city recently awarded a sewer contract to the low bidder in spite of his protestations that he had made a mistake of $10,000 in totaling up his bid. He told the board that there was a clerical error in his bid of $35,609, and that he meant to place the figures at $45,609. His original bid, as submitted, was $10,833 lower than the next lowest, and if the board had allowed him to alter it as he requested, he would still have been the low bidder. However, it was the opinion of the board that it had no legal right to recognize the contractor's claim that an error had been made, and its only course was to award him the contract upon his original bid. The engineer's estimate was $44,000.

A southern city has just sued a bridge contractor for $50,000 damages because of his failure to stand by his bid of $434,400 to build a 2,500-ft. concrete bridge across the Arkansas river. The contractor claimed he made errors in his bid and therefore withdrew it. He said he intended bidding $493,598 instead of $434,400.

Another contractor found himself in embarrassing circumstances because he bid $4,477.90 per lineal foot for constructing a sewer when he was not only willing, but anxious, to take the entire job at that figure. This was one major item on a $200,000 job. As he was low bidder, when the sum named was taken to cover the job, it is thought he will get the contract.

Other evidences of carelessness in submitting bids on public works construction could be cited, but these are sufficient. The penalty for errors of this sort is heavy. In the first case cited,for example, the bidder's mistake will cost him a round $10,000. It is hard to tell how the second man will come out in his $50,000 damage suit, but he can't get the best of it, that's sure. The third man had only the job to lose, but as it was a $200,000 contract he was bidding for, that was something to lose, assuming, of course, that his bid was safe as corrected.

Bids of the sort mentioned have the smack of too much conviviality. Contractors should submit their bids before sitting in at the poker game, not afterwards.

Of course, contractors will make mistakes, but these should be rigidly excluded from bids. Mistakes in judgment will influence the bids of the most careful, but a clerical error in a bid is ample evidence that the contractor is only one hop ahead of the fast-going fool catcher.

THE CONTRACTOR AND PUBLICITY

When it comes to modesty the violet has little, if anything, on the contractor. The contractor is obliging enough, and if cornered by an editor will disgorge all kinds of much wanted information. His native desire to do something for the other fellow prompts him to take this action. But when the suggestion is made that he go in for a little publicity on his own account he blushes, twirls his hat, and begs to be excused. This is unfortunate—for the contractor and the public alike.

The public needs to know the modern contractor better than it does, and he needs to be better known than he is. There have been enough graft stories printed in newspapers, involving public officials and public works contractors, to give the average misinformed citizen the impression that the contractor is "a slick fellow who will bear watching." That this is a grossly unjust attitude need not be argued here.

If that is the popular conception of the contractor, and there seems good reason for thinking that it is, what can he do to change the popular attitude towards the contracting business?

An answer to this query is found in some publicity work recently carried on by Chicago paving contractors. These men have conducted an advertising campaign, which had for its object the upbuilding of popular confidence in the paving work done by this city and in the contractors themselves as responsible business men. Something of the sort was clearly needed in this locality to offset the left-handed advertising paving contractors have had on several occasions in recent years. Many people, with the best of intentions to be just and fair, had obtained the impression from an occasional newspaper story that Chicago pavements are lean in quantity and poor in quality.

An important incidental aim of the campaign was to arouse the interest of the people in street paving in general. This interest, aroused, would naturally lead to more pavement construction, calling, of course, for the services of the paving contractor. This is merely the familiar form of commercial advertising adapted to the contractor's needs.

The background against which the campaign was projected was the general principle that a pavement contractor is a man with service to sell. The taxpayers are his customers, and it is not only desirable, but requisite, that they should know of him and have confidence in his work. In a big city the individual taxpayer has small opportunity to know the contractor personally and meets only his subordinates. In such cities the contractors will do well to advertise when the occasion is appropriate. A little judicious newspaper advertising will also gain the good will of the newspapers. Certainly no one could doubt the value of this.

In many ways the contractor should come out of his self-imposed exile. He should be more active in conventions and he should write vastly more than he does for the technical and popular press. He should learn that it pays to advertise.

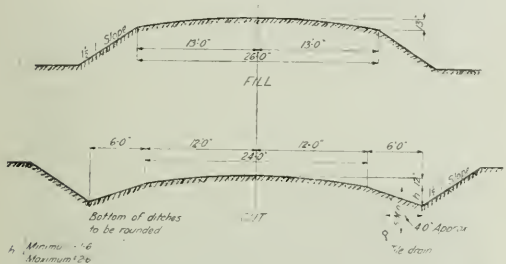
Outstanding Features of the Work of Various State Highway Departments This Season

THIS has been an important year in state highway construction, and this resume of the outstanding features of the work in various departments is based on the editor's correspondence with department officials.

—Iowa—

Under date of September 5, J. W. Eichinger, bulletin editor of the Iowa State Highway Commission, Ames, wrote as follows relative to the salient features of Iowa road dseign, construction and maintenance during 1917:

The most outstanding feature of the construction work, as it appears to us at the present time, is the comparatively higher class of work which counties are securing this season.



STANDARD CROSS-SECTIONS FOR EARTH ROADS, COUNTY ROAD SYSTEM SERIES OF 1917, IOWA STATE HIGHWAY COMMISSION.

This is due largely to four years of education on the part of both the highway commission and county engineers. Road foremen understand to-day far better than they did four years ago, when present road laws became effective, the building of roads according to blueprints. Viewing the results of their work from year to year, they have been learning more fully each season how much more satisfactory it is to do a creditable piece of work than to do the old-fashioned slipshod type. The better class of men are learning to take pride in their work. Foremen are now able to secure and keep a better trained class of workmen than they could in the past. This means a great deal in securing good work.

Engineers are also becoming far more insistent on contractors and foremen leaving better finished and more workmanlike jobs than formerly. A few county engineers have it in their contract agreement that after a job has been practically completed, it be allowed to pack and settle for a time, when new shoulder lines shall be run by the engineer and the contractor give the job a final trimming up before final acceptance. A higher class of work, better and more perfectly finished to both grade line and cross-section, is, in our opinion, the most outstanding feature of road construction in Iowa this season.

As for maintenance, the establishment of a compulsory patrol system over the entire county road system undoubtedly will mean much ultimately for Iowa road maintenance. Each patrolman is to give his entire time to a definite section of road and be entirely responsible for dragging and all maintenance features. The law did not become effective until July 4, after all counties had their plans and appropriations made for the season, so that it has not been very effectively in operation this season. Several counties, however, have had the system in use several seasons of course, with very gratifying results.

As for design, there has been no change in the Iowa standard cross-sections in any way in the past four years. These standards were adopted at that time after some ten years' study and experimentation in road design under soil and climatic conditions as they prevail in Iowa.

Herewith is illustrated our standard cross-section for cut and fill on the county road system of the state, which comprises some 17,000 miles of the more important highways, connecting up county seats and market places. The standard cross-section for the township road system of lesser roads, of which there are some 85,000 miles, is identical except 4 ft. narrower in width. Taking 4 ft. out of the center of the section leaves the section perfect for the township standard.

The cross-section on fill calls for a width of 26 ft., shoulder to shoulder, with a crown of 13 in. in the center, a slope of an inch to the foot. The standard side slope is 1½ to 1. The cross-section in cut calls for a shoulder-to-shoulder width of 24 ft., with a crown of 12 ft. Standard back slope of side ditch is 1½ to 1. Distance from shoulder to center of ditch is 6 ft., with depth varying from minimum of 1 ft. 6 in. to 2 ft. 6 in.

The standard Iowa cross-section has been criticised as being too heavy. Engineers have insisted that the ditch is of unreasonably large size. The results of four years of statewide experience amply justify the present standard design in every way. No change has been made and none is deemed likely to be made.

The Iowa cross-section is designed to produce a dirt road that will last and bear the traffic and weather conditions to which it is subjected for a considerable period of years, with the lowest possible maintenance cost. Iowa is to-day building almost no surfaced roadways. She has 104,000 miles of road, almost every mile of which must be kept in usable condition, for almost every quarter section of Iowa land is a productive farm and must have its market road. The extent of the mileage makes it impossible that any considerable percentage of the roads be surfaced in the near future. Road builders are confident, however, that Iowa will make rapid progress in actually paving her important highways when she does start, and have designed the Iowa standard with the view of not only giving service now as a dirt road, but of supplying the best possible foundation without rebuilding for the paved surface when the time comes to put it on. Packing and settling under traffic and weather conditions for a period of years, together with careful patrol maintenance during this period, should produce the best foundation for hard surfacing it is possible to build out of dirt. It is manifestly impossible to secure as satisfactory and substantial a foundation out of new construction.

The cross-section has been planned for economical construction. The perfect cross-section can be shaped up with tractor and blade grader. Ordinary maintenance methods can accommodate the cross-section to varying qualities of soil. Some sections of the state will stand a flatter crown than others. Road draggers reverse the drags from time to time in these districts and throw the dirt to the outer edges instead of the center. If a higher crown is necessary, draggers continue to throw the dirt toward the center.

The width of the cross-section has been determined with a view of meeting traffic conditions, as they can be easily foreseen for the near future, not alone for the needs of to-day. The narrow road grade that was ample for the slow-moving horse traffic, experience to-day is showing to be utterly inadequate for the fast-moving motor vehicle traffic. A traffic census in progress to-day shows that on some roads the motor freight traffic almost equals the horse freight traffic. Conditions in the next four or five years can be readily foreseen.

The Iowa standard gives ample roadway for three fast-moving vehicles to pass, with a good large zone of safety for dirt road conditions between.

The side ditches are designed to be built with the tractor and blade grader. They are of sufficient size to prevent their being readily filled and clogged up. They can be cleaned and rebuilt with tractor and grader when such action becomes necessary, at comparatively low cost. In addition, the counties are putting in thousands of yards of tile underdrainage, where conditions warrant this expenditure. The location of the drain is shown on the cross-section drawing.

In addition to the permanent grading work, topography of a great many counties is such that thousands of miles of road are being built with blade graders alone, putting the road to standard cross-section, but to natural grade. This permits of a large mileage of improved road at comparatively low construction cost. The commission limits the amount of money that may be spent on this type of construction, however, to

VIEW OF BITUMINOUS MACADAM ROAD BUILT BY PENETRATION METHOD, WAYNESBORO, VA.

$60 per mile. If the estimate shows the expense of construction to be over this figure, complete surveys for a permanent grade, plans and profile must be made and approved by the commission before the work is allowed to proceed.

—Virginia—

C. B. Scott, assistant commissioner of highways of Virginia, Richmond, writes:

The most noticeable advance in road improvement in this state during the last year is the inauguration of a system of state aid for maintenance for public highways constructed with state aid or county bond issues. That law went into effect June 17, 1916, but practically no funds were available to carry on the work until January 1, 1917. The state automobile tax, amounting this year to something like $475,000, is thus set aside for maintenance. The money is appropriated to the several counties according to the amount paid into the state treasury in general taxes, and the counties are required to put up an equal amount to that received from the state, thus making a joint fund double the amount of the automobile tax.

Heretofore the state aid roads, when constructed, were turned over to the local road authorities for maintenance, and as they were superior to the unimproved public highways they were generally neglected until in many cases the surfacing was practically worn off. This was also the case with county bond issue roads, and was a most unbusinesslike policy, where bonds were being issued for road improvement and the roads were being allowed to go to pieces long before the bonds were paid.

The accompanying view shows a macadam road built this season.

—North Carolina—

W. S. Fallis, state highway engineer of North Carolina, Raleigh, writes as follows of his work this season:

Our commission is this year organizing for the maintenance of a system of state highways as provided by our last legislature. These highways will be maintained in whatever condition we find them and in whatever condition the counties arrange to construct, or in whatever condition they are placed by the Federal aid road fund.

We are dividing the state into divisions, putting maintenance engineers in each division, with a chief of maintenance engineer to supervise the work generally. This work will be carried on in the main by the patrol system, using a patrolman for each section, taking care of the work in that particular division. The patrolman is responsible to the division engineer; the division engineer is responsible to the maintenance engineer, and the maintenance engineer is responsible to the state highway engineer.

We expect to arrange this system of maintenance on thru roads only—that is, roads connecting county seat with county seat—and we hope to keep all these roads in passable condition through the entire year. Many of these roads are in excellent condition, and we have one stretch of 400 miles that we hope to have within the next 18 months so it will be open for the entire year for automobile travel. Many sections of this road will be of the highest class, while others will be of sand-clay gravel. We hope to have the entire mileage of sand-clay gravel, brick or bituminous material within the next 18 months, with no grade in the 400 miles exceeding 4½ per cent.

We expect also to have two roads running north and south thru the state in the same condition, and we will, so far as may be necessary, concentrate our maintenance efforts on these roads.

—Texas—

Julian Montgomery, chief office engineer, Texas State Highway Department, Austin, writes that the department was organized only a couple of months ago. No construction has as yet been undertaken, and the question of maintenance is, of course, in the future. The designs are practically complete, but have not yet been finally approved.

—Nebraska—

Geo. E. Johnson, state engineer of irrigation, highways and drainage of Nebraska, Lincoln, writes:

As it is necessary to lay out some 4,000 miles of roads, connecting our county seats, before starting any construction work with state and federal money, we have been unable to award any contracts this season.

These roads are all located now, with the exception of four counties, and we expect to have the location of the system completed within the next ten days, get our projects approved by the government, and be in position to award contracts by the 20th of January. We will start on nineteen different projects, and expect to spend $1,250,000 in the year 1918.

—Delaware—

Charles Upham, chief engineer, Delaware State Highway Department, Dover, writes that the department has been organized only two months, and is at present busy in preparing specifications, standards, etc. He hopes that by the spring of 1918 he will have at least 100 miles of surveys completed and be in position to construct as many miles as the Highway Commission deem advisable. His plans and specifications will conform with the suggestions and standards of the United States Government for Federal Aid Projects.

—Oklahoma—

Max L. Cunningham, state engineer of Oklahoma City, writes:

"Owing to the fact that 1916 was election year and this

office has less control than we should have of county expenditures, there has been practically no work done during the portion of 1917 just passed, and that our working season really begins about October and our best work is done during the winter months, we are unable to state definitely what we will accomplish owing to the fact that many of the counties have not yet completed their tax levies, and we cannot tell what funds will be available."

—Nevada—

Nevada recently created a State Highway Department. R. K. West is state highway engineer, Carson City.

—Mississippi—

Xavier A. Kramer, Mississippi state highway engineer, Jackson, submits the following information relative to road work in that state:

The Mississippi state highway department is a new department, as it has only been in existence about a year, and, as is usually the case with a new department, a very small appropriation was made, so naturally it has been handicapped. The department has recommended a system of connected highways through the state and has a large portion either completed, under construction or being promoted. When these roads are completed, Mississippi will have one of the best system of highways in the south.

VIEW OF A MISSISSIPPI GRAVEL ROAD.

Various types of roads have been built, but on account of the deposit of a good grade of sand-clay-gravel in a number of the counties in the state, gravel surfaced roads have been constructed in a larger portion of the state. This local gravel is usually put upon the road as it comes out of the pit, however, in some instances it becomes necessary to mix a small percentage of clay with it in order to make it bind properly. The sub-grade is cut and rolled as in ordinary macadam roads with proper earth shoulders to keep the gravel from washing off the road. The gravel is then spread in a uniform depth of 8 ins. on the sub-grade and rolled with a roller weighing from 5 to 10 tons. After the gravel has been rolled, it is necessary to shape up the gravel for a few weeks after each rain until it is properly set up, after which it presents a smooth, hard surfaced road that holds up well under ordinary traffic, and with proper maintenance will last for several years without resurfacing. A view of a Mississippi gravel road is shown herewith.

On the more important and extensively traveled roads a superficial surface treatment of "Tarvia," asphaltic tar, or light road oil, is applied which gives a dustless road and increases the life of the road.

In localities where rock is convenient, it is crushed to a 3-in. size and put on the road as a base, 8 ins. in depth, and then covered with a 3-in. layer of sand-clay-gravel, which, after being compacted, makes a very serviceable hard surfaced road.

In counties where gravel and rock are not convenient and freight rates on surfacing material is prohibitive, a surfacing of sand-clay is used. This makes a good, serviceable road for light traffic.

In the poorer counties where funds are limited, roads are graded and drained, which is a great improvement over the ordinary Mississippi roads. At some future time when funds become available, a hard surfacing can be applied without any loss of the previous work.

In Lee county several miles of concrete roads with gravel shoulders have been built. This makes a much more permanent road and reduces the maintenance costs.

Various methods of road maintenance are in vogue in different parts of the state. Some counties let their improved roads out to a responsible road contractor for a fixed amount per mile per year, while others use a competent road superintendent with teams and labor to keep their roads in proper repair. In a few instances the counties have purchased motor trucks to do all of their hauling, dragging, machining, etc. This has proved to be a very cheap and satisfactory manner of road maintenance, as it enables them to cover their whole road system in an efficient and satisfactory manner.

Herewith is an approximate cost of the various types of road construction in the state:

Type of Road	Cost Per Mile
Graded and drained roads	$ 500 to $1,000
Sand-clay roads	1,200 to 1,800
Gravel roads	1,800 to 4,500
Gravel roads with superficial coat oil, etc.	2,200 to 5,000
Concrete roads	9,000

—Illinois—

W. W. Marr, chief highway engineer, division of highways, department of public works and buildings, Springfield, writes:

The construction of state aid roads in Illinois has followed closely standard specifications and well-established practice. On account of increased prices of road material and labor, attention has been directed in the way of drainage and grading earth roads to a permanent grade line.

There is still considerable enthusiasm in this state for oiled earth roads. Nearly every county in the state has oiled a few roads. The high price of road oil and the difficulty experienced in getting shipments have retarded the work somewhat. It is estimated that 4,000 or 5,000 miles of earth roads have been oiled this year by townships, counties and the state.

There have been completed this year more than 100 miles of hard surfaced state aid roads. Approximately 70 per cent of the work has been of concrete, 10 per cent brick and 20 per cent of other types such as gravel, macadam and bituminous roads.

The chief deviation from standard practice in concrete road construction has been the elimination of all transverse joints. Approximately 90 per cent of all contractors on concrete road construction are now using the belt finish in preference to hard floating. About 10 per cent of the contractors are using the light hand roller on the soft concrete preparatory to the belt finish. It is hoped that all contractors will use the roller for compacting the concrete and the belt for finishing the pavement by next year, as it is very evident that better results are obtained.

On brick road construction our specifications require the monolithic or semi-monolithic type. There seems to be a preference for the true-monolithic, that is, where the bricks are laid upon the soft concrete base. The semi-monolithic, that is, laying the brick upon a dry sand cement cushion, is used only where conditions indicate that such construction will be more practical or economical.

The chief maintenance work in this state has been to fill almost exclusively in maintenance work. The truck carries a all cracks and joints in concrete and brick pavements, apply bituminous surfaces to gravel, waterbound macadam and bitmuminous roads. The small Ford auto truck is used healing kettle and all small tools necessary to attend to the maintenance on the average job. Such equipment has proved to be very satisfactory for filling cracks and joints in brick and concrete pavements.

—South Dakota—

Homer M. Derr, secretary of the South Dakota state highway commission, Pierre, writes that the commission is just now getting organized, and plans and specifications have not as yet been drawn or any road work whatever been done under the auspices of the commission. He goes on to say: "The law establishing this commission did not go into effect until July 1, 1917, and circumstances have been such that it bas been almost impossible for the chairman to have official meetings to transact business. We are just now very busy in making out a five-year program for state work on which there will be available $1,214,190.30 federal aid, and our legislature has appropriated $250,000 for road work the first two years, which latter is intended to match dollar for dollar the federal aid the first two years, and to cover all necessary office expenses and expenses for engineering services in the field, including the salary of the highway engineer. We have not as yet been able to even formulate our first project statement, but hope to be in a position to do so quite soon."

—West Virginia—

A. Dennis Williams, engineer, chairman West Virginia state road commission, Charleston, gives us this review of the work of the commission:

The West Virginia state road commission was created by act of the legislature 1917. The new commission consists of T. S. Scanlon, secretary-treasurer, and A. D. Williams, chairman. They were appointed and assumed duties June 1. The commission has charge of the collection and disbursement of the automobile tax, the regulation of traffic upon the public highways and the establishment, location and general supervision and construction of the Class A or main county roads in conjnnction with the county courts.

Since 1912 there has been voted $17,291,000 for road improvement in West Virginia. Under the new law, the levies provided are 25c for the Class A or main county roads upon all taxable property in each county, or so much thereof as the courts may lay, and in addition a 15c special district levy. To this can be added two special emergency levies in case of flood or other destruction to roads or bridges.

The state road system, comprising approximately 4,600 miles of road, has been about completed in location. This mileage will be within one mile of 80 per cent of the people of the state, no section of the state will be over 12 miles from a Class A road. This system will connect all of our important towns and county seats.

Up to date we have 28,500 automobile licenses issued. For the fiscal year 1905 there were 176 automobile licenses issued in the state of West Virginia.

Standard designs of bridges, culverts and specifications are being prepared for publication. For the coming year efforts will be made to get the state system of roads graded, ditched and drained, but until prices of material and transportation conditions change our policy will be to expend our funds and energy in this direction, using, of course, local materials wherever practical and possible.

—Indiana—

William S. Moore, engineer of the Indiana state highway commission, Indianapolis, writes as follows:

The new Indiana state highway commission consists of four members: Mr. L. H. Wright, chairman, Mr. Haines Egbert, Mr. D. C. Jenkins and Mr. Lewis Taylor. This commission is what might be called a continuing commission—there is one member appointed for four years, one for three years, one for two years and one for one year. After that all members will be appointed for the term of four years.

William S. Moore has been appointed state highway engineer and is also by virtue of his office secretary of the commission. The commission is provided with state funds and will also have charge of all federal aid money.

It is the present intention of the commission to designate about four roads, one passing through the center part of the state from north to south, starting at South Bend through Indianapolis to New Albany; one road across the northern portion of the state, which is commonly known as the Lincoln Highway, passing through Fort Wayne, South Bend and Valparaiso, and one road passing through the center, commonly known as the "Old National Road" starting at Richmond through Indianapolis to Terre Haute. The road across the southern part of the state has not been definitely decided upon, but will probably start at Lawrenceburg and terminate at Evansville. These four roads will be approximately 800 miles long.

The commission expects to put all of next year's state and federal money on the improvement of these roads, and later on additional mileage will be laid out up to the 2,000 miles, which is all the commission has authority to lay out before January 1, 1920.

Large Rustic Swimming Pools Constructed at Small Cost

The West Chicago Park Commissioners have under construction in Columbus Park two swimming pools that present features of interest, both on account of the large size of the

VIEWS ON CONSTRUCTION OF CHICAGO PARK SWIMMING POOLS OF UNIQUE DESIGN.

pools and the remarkably pleasing rustic appearance attained at comparatively low cost.

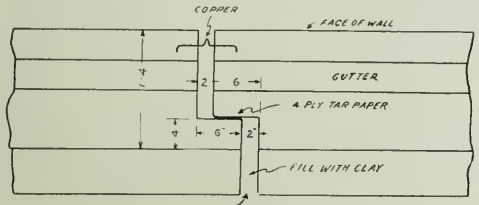
Design

Columbus Park is a new park, comprising about 145 acres, located in the extreme west central part of the city, and has been under construction for about two years. The pools are

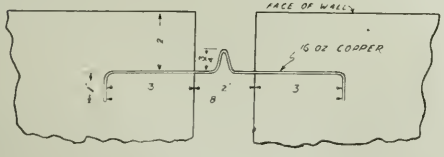
near the eastern side of the park and are of irregular circular design to meet the conditions of the location and give them a more natural appearance. The larger pool is designed for a water depth at one end of 3 ft., sloping to 4½ ft. at the other, has an area of 23,430 sq. ft. and is formed by arcs of 13 points of tangent. The smaller pool is designed for a water depth of 8 ft. at one side, sloping to 9 ft. at the other, has an area of 7,280 sq. ft. and is formed from the acrs of 6 points of tangent. The entire floors and side-walls of both pools are made of 1:3:5 concrete, except that the floors are faced with one inch of 1 to 1 concrete. The walls will be capped with natural rock flagging, which will be carried back to form ledges and diving platforms, and at the side of the smaller pool will be a rock ledge ravine through which water from an artificial spring will flow into the pool. The entire surrounding area will be graded and planted with trees and shrubbery with the view of giving greatest naturalness to the appearance of the pools and landscape.

Structural Features

The structural features of greatest interest are the expansion joints in floors and side walls. The floors were laid in 30-ft. slabs extending across the pools with 5 ft. square marked joints, the slabs being laid alternately to provide for contraction. Between the slabs extending across the pools are 1-inch expansion joints and 2-inch expansion joints are carried entirely around the floors of the pools immediately adjoining the side-walls. These joints are packed with oakum to within 2 in. of the surface and the remaining space filled with tar. The side-walls are 6 to 12 ft. high, with 16-in. tops, 3 ft. to 3 ft. 6 in. footings, have 1 in 10 in. batters, and are provided with slip expansion joints. These joints provide for a 2-in. expansion and are spaced about 60 ft. apart in the walls. About 2 in. from the inner face of the walls in the expansion joints is a sheet of 16 oz. copper extending from the top to



DETAIL OF SLIP JOINT



DETAIL OF COPPER EXPANSION JOINT

DETAILS OF SLIP AND EXPANSION JOINTS.

the bottom of the wall. This copper sheet is crimped in the center to provide for expansion and bent back at right angles at the sides to form anchorages in the walls. The overlapping concrete faces of the slip joints are separated by four-ply tar paper. These joints were made by using taper forms and pulling the forms after the concrete had set but before it had become entirely dry.

At about 30 ft. distances around the top of the side-walls leading from a recessed inlet extending half the distance thru the wall are 4-in. cast-iron overflow pipes fitted with strainers. Each pool has a 6-in. water supply pipe and a 12-In. outlet drain. It is proposed to renew about 20 per cent. of the water every night and once each week the pools will be completely drained and the floors and side-walls scrubbed with an acid solution.

The contract for the excavation and concrete work of the two pools was let March 27, 1917, to J. J. Croake & Co., 2929 Fullerton avenue, Chicago, for $15,691. Material for the concrete was delivered in motor trucks to the most convenient locations for rapid work surrounding the pools, and all mixing was done in a 1/3-yd. "The Standard" Low Charging Mixer, the portability of which permitted it to be quickly moved along as the work progressed, reducing the wheeling of material and concrete to the minimum.

This is the thirteenth park the West Chicago Park Commissioners have equipped with swimming pools, the design and construction of which have been under the direct supervision of Mr. A. C. Schrader, chief engineer. Plans for swimming pools in two other parks are now in preparation. During 1916 the pools of ten of these parks were in service and were patronized by 877,232 men and 375,075 woman bathers.

Getting Action on Long-Delayed Street Widening Job

The widening of Twelfth street, Chicago, is one of the projects Chicagoans have read much about in recent years. To many persons this project had come to be almost as elusive as the construction of passenger subways, the construction of the "boulevard link," the electrification of the Illinois Central terminal lines, the development of the lake front parking program and other much-wanted improvements which were said to be on the way yet never seemed to arrive. That the dirt has been flying on the Twelfth street job recently, however, can be seen from the accompanying views.

This job was held up by people owning property along the portion of the street that was marked for widening. Of course most of the owners of abutting property favored the improvement, but there were enough of contrary mind to "hang the jury" for a good while. M. J. Faherty, president of the board of local improvements, forced the cases to trial and got the property condemned. He also had the state legislature pass an amendment to the Illinois local improvement act, which is so full of checks and balances that it makes it almost impossible for a city to get anywhere with anything, to allow the board to borrow 50 per cent of the amount of the assessment levied to defray the cost of the improvement, to be paid back when collected, so that the board could immediately pay the awards for the property condemned. Mr. Faherty then started the condemnation proceedings and then built new sidewalks and pavements and these were paid for in the usual manner by special assessment funds.

Mr. Faherty has been out on the job every day since August 1, 1916. As soon as the city got possession of the property 200 buildings were moved back in less than six months. All frame buildings were destroyed. Brick buildings were moved back bodily or cut off and given a new front. These new fronts add greatly to the appearance of the street. Each property owner made his own contract for the requisite physical changes. Three buildings were destroyed where the board was unable to settle with the owners at a generous price —this is vacant property now.

This work first came up for a public hearing four years ago. It is a part of the Burnham plan for the new city of Chicago. The widening will extend from Michigan to Ashland avenue, a distance of 2¼ miles. From Ashland avenue to Canal street Twelfth street is widened 42 ft., making an 108-ft. street, and is widened 52 ft. between Canal street and Michigan avenue, making an 118-ft. street.

The widening is entirely on the south side of the street.

The damages would have been practically doubled by taking off some of the private property on the north side of the street as well. The result has been, of course, the widening of the street at the expense of shortening the lots abutting along the south side.

Everybody that owned affected property and would listen to reason made money. The value of the abutting land was increased about 50 per cent by the improvement and this amounted to about three times the assessment.

A new 22-ft. concrete walk is being laid along the south side of the street. The roadway, 70 ft. wide, is being repaved with granite block. The street was formerly paved with brick. It is a heavy traffic street and has a double street car line. The paving assessment has been confirmed and the work is progressing. New street car tracks have been laid for a distance of one mile. The city brought holes made by the removal operations up to grade by filling with sand. The Chicago city railway paid for the new concrete base for its tracks and moved its rails. The great Twelfth street viaducts are within the affected area and as these are railway properties they are to be paved at the expense of the railroads and new viaducts are to be built. The cost of the property condemnation alone on this improvement was $3,500,000.

VIEWS SHOWING THE WIDENING OF TWELFTH STREET, CHICAGO.

Most of the house-moving jobs incident to the widening of this street were simple enough. One large stone church was moved and one four-story brick building of 400-ft. frontage.

From Ashland avenue to Canal street, Twelfth street will be ready for traffic by November 1 of this year. The balance of the work will probably be completed within a year. The total cost of the work will reach $6,500,000.

The engineering work has been handled by the staff of the board of local improvements, C. D. Hill, chief engineer. W. F. Cummings is contractor on the street work now nearing completion.

Pavement Design and Construction

Present Practice in the Construction of Brick Pavements in Chicago

By H. J. Fixmer, Division Engineer in Charge Paving Construction, Board of Local Improvements, Chicago, Ill.

In all types of pavement construction it is our endeavor to build a pavement that will fulfill the requirements of the traffic using it.

Forces Acting on Pavement.

The kind of traffic using the city street and main road today is greater in volume and weight and more rapid and important than the traffic of former days. Brick construction is, as a general rule, only specified on thorofares inviting this kind of traffic. After analyzing the effects imposed on pavement construction by mixed types of vehicles, with the motor truck predominating, we are able, in time, to devise or indicate the methods to be observed in evolving a pavement that will accommodate the traffic in a satisfactory manner. The increased weight of the heavy motor truck is, statically considered, better distributed over the surface of the pavement, because of the width and resilient quality of the tire. This, in turn, is greatly counterbalanced by the impact produced by the increased speed of the vehicle. The driving wheels of the motor truck generate more friction and exert a powerful shearing force on the surface of the pavement.

In addition to the forces constantly exerted, but in varying amount, by the traffic on the surface of the pavement, there are present at times other natural forces tending to destroy the pavement structure.

These forces are, briefly, expansion and contraction, caused by climatic changes; the action of free water, in the form of frost, as a solvent, as a carrier and as an agency in compacting soils, causing settlement; and decay or deterioration caused by defects in the material, or a combination of the destructive agencies of nature.

The Foundation.

The subgrade must be properly compacted and drained. This requirement is worth all it costs, regardless of the type of pavement used, because it is virtually of permanent value.

The base or foundation of the pavement should be an unyielding structure, preferably of concrete. Where a grout filler is used good results have been secured with a macadam base, but for heavy traffic concrete is more reliable. The quality and thickness of the concrete require study and should be proportioned to satisfy the conditions of the subgrade character of

wearing surface and the amount and weight of traffic to be borne.

The "Cushion."

On the foundation there is usually placed a so-called "cushion" of sand, bituminous mastic or cement mortar.

The purpose of this layer is to form a smooth surface that will adapt itself to the uneven surface of the base and in inequalities of the bottom surface of the individual brick. Until recently it was believed that the "cushion" served to reduce the effect of impact on the surface of the individual brick. It is now well recognized that the sole function of the "cushion" is to afford an even bearing for the brick on the foundation.

Sand serves well for this purpose, provided it can be kept in rigid position. Experience has shown that vibration and the percolation of water tend to shift the sand, causing the pavement surface to settle unevenly. For this reason it is considered better practice to add cement to the sand in the proportion of 1 to 3 or 1 to 4, and wet the cushion thru the joints after the bricks are properly bedded. This enables the cushion to set up and maintain an even bearing on the concrete, regardless of the joint filler used. A serious objection to the sand cushion is its tendency to work up to the top of the brick thru the joints, particularly if the pavement is rolled too much. A sand having up to 10 per cent of loam will not roll up in the joints as much as a clean, fine sand. Where an asphalt or tar filler is used it is no disadvantage to have some of the sand come up in the joints, for it is readily penetrated by the hot bitumen and becomes a stiff mastic. Where the filler is grout the presence of sand in the joints prevents the penetration of the filler and results in the development of weak spots, which quickly become loose. The sand in the joints filters the water out, leaving a thin mortar, which dries out and does not set up properly. Where a grout filler is to be used, a mortar cushion should be provided. This cushion can be laid dry and wetted by sprinkling either immediately before laying the bricks or thru the joints after the bricks are rolled.

Because of the effect of impact of traffic a smooth surface is imperative. Many years ago brick pavements were rolled with a horse-drawn roller and the joints filled with sand. A few of these pavements are in existence to-day as monuments to the enduring quality of brick as a paving material. The joints are open and very wide, due to the rounding off of the upper edges of the individual brick. Even where the bricks were narrow there are few broken bricks.

It can be safely stated that brick is highly resistant to fracture or crushing where evenly bedded. It wears by abrasion, the amount depending on the uniform hardness or toughness of the brick and the support or protection given the joints. The quality of brick is well standardized, and its toughness, both as to degree and uniformity, readily tested.

Joint Filler.

Having secured an even surface by proper rolling and having the bricks evenly bedded on a fixed cushion, our remaining problem is to secure an adequate joint filler. The joint filler must be one that remains in place at the top surface to protect the joints and maintain an even wearing surface.

In Chicago four kinds of joint filler have been used, namely, sand, tar, asphalt and cement grout. Sand is not satisfactory. Tar has, as a rule, given poor results, particularly in recent years. It wears, breaks or flows away, leaving the upper part of the joint exposed to wear and the accumulation of filth. It is believed that the extreme range of temperature in this locality destroys its efficiency, and for this reason we are limiting ourselves to the use of asphalt and cement grout. Asphalt has given general satisfaction. It adheres well to the sides and tops of the bricks, filling any surface inequality and giving a smooth, durable surface. Pavements five years old have the asphalt flush with the joints and a thin surfacing in spots. Where the grades of the street vary greatly or are excessive, an asphalt filler should be preferred. The use of the grout filler has been revived this year, and where a grout cushion is used excellent results are expected.

The grout is mixed in the standard proportion of equal parts of cement and sand. On some jobs the standard hand-mixing box was used. On one job the material was mixed in a small batch mixer and conveyed to the grouting area in carts having revolving paddles fixed to the axle of the wheels. In this way the mixture was kept agitated, and when dumped was of even color and uniform consistency. The grout was applied in two courses, and rarely required three applications. A stiff broom was used with the thin, or first, application, and a rubber squeegee with the final application. A smooth surface was secured, the joints filled flush and any slight defects in the brick evenly filled. The streets were barricaded seven or more days and kept sprinkled for the first three days. Where a repressed brick or a mortar cushion was used, one barrel of cement filled 29 sq. yds. of pavement. Where a lug (wire-cut) brick was used on a sand cushion, one barrel of cement was used to form 24 to 28 sq. yds. of pavement. This variation is due to the amount of sand coming up in the joints. On the cement-sand cushion, mixed 1 part cement to 4 parts sand, one barrel of cement laid 18 sq. yds. 1 in. thick.

Where a sand cushion was used some trouble was experienced in getting the proper amount of grout in the joints, due to the cushion working up, necessitating taking up and relaying the brick.

Details of Construction.

On the brick pavements laid under my direction this year the middle 16 ft. is occupied and constructed by the street railway company. This middle strip is paved with granite blocks with a grout filler. On these streets four rows of granite blocks are laid outside the rail on a mortar cushion. On one street the granite strips were filled with tar and torpedo sand, the other streets having the granite filled with grout similar to the adjacent brick pavement. An expansion joint, filled with bitumen, is provided along the face of the curb and continued across intersecting streets and alleys. No transverse expansion joints are built.

The purpose of using the four rows of granite blocks outside the rail was to take care of the excessive wear due to the habit of vehicles driving along the rails and turning out abruptly. The four rows extend beyond the ends of the ties, and, where the joints are filled with bitumen, little, if any, vibration is communicated to the adjacent monolithic brick slab.

In order to minimize the effect of expansion, the crown was made as slight as practicable, and no abrupt changes, such as raised cross-walks, built at intersecting streets, as was formerly the practice. The pavement is built flush with the curb for a width of 6 ft., corresponding with the sidewalk, across the alley and street intersections, along the line of the maximum pedestrian traffic. At the curb corners the pavement is 4 to 6 in. below the rail (curb grade), running thence to the inlet located about 50 ft. from the curb corner. The crown at the inlet varies from 8 to 10 in. below the rail or curb, depending on the width of the roadway. This construction creates a step of from 5 to 7 in. at the cross-walk crossing the street. This tends to cause a pedestrian to pause before crossing the busy street and eliminates the familiar "bump" in the line of greatest vehicle traffic. A grout-filled brick pavement laid on a 1-in. mortar cushion, on a 6-in. cement base, is rigid and semi-monolithic. It is believed that this type will prove satisfactory for the traffic and will resist climatic changes. The cushion should set up with the grout in the joints, permitting the concrete to slide under the cushion and thus not communicate cracks from the base up thru the pavement. Since the pavement is smooth, its rigidity, or lack of (alleged)

"elasticity," gives a more durable and comfortable surface for all types of wheel traffic. All vehicles are now equipped with springs and a majority travel on rubber tires.

The horse is destined to disappear from the city street. If used, he should be shod with rubber or other smooth shoes.

Conclusions.

Some objection has been raised that the grout-filled pavement is difficult to tear up, and even more difficult to repair. This is true. However, we are not building pavements for the purpose of tearing them up readily. This is a questionable, or at most an incidental, defect. This type of pavement can be properly repaired, but it requires skill and care. It is the writer's opinion that an asphalt or grout-filled brick pavement on a 1-in. mortar cushion, on a good 6-in. concrete base, is an excellent type for the normal business or car-line street. It will require very little repairs or maintenance. Where the filler wears down, the pavement can be restored by a light application of hot asphalt, with a sand dressing. If this is done regularly, say every three to five years, the pavement should last from twenty-five to forty years and be in a smooth condition all that time. The new ideal pavement must have the qualities of smoothness, rigidity, durability, strength, good traction, be comfortable to ride upon, and be easily cleaned. A properly constructed brick pavement realizes all these advantages to a noticeable extent.

The Construction of Concrete Curbs for Asphalt Roads

Concrete headers or curbs for bituminous roads are being provided for in a great deal of road building where formerly it was not considered necessary, whether or not a concrete base was used. Probably no type of road is increasing in popularity more rapidly than the concrete-base asphalt top, or so-called combination road. This fact makes it all the more desirable to emphasize the necessity of side support for such roads, and this can only be effectively provided for by concrete curbs.

The good reputation of asphalt wearing surfaces is based largely upon the performance of such surfaces on city streets, where curbs are almost invariably provided. In proportion to the traffic carried, such side support is just as necessary on roads as for pavements. A very good example of the truth of this statement was noted recently during the inspection of a Long Island Topeka specification road, now five years old, and in good condition except along the edges, where the asphalt top was almost continuously broken down along the shoulder of the road. The maintenance of something more than a mile of this road for the five-year period would have amounted to practically nothing but for the repairs necessary at the edges of the road, all of which would have been avoided if a concrete curb or header had been provided in the first instance.

The concrete header is not only desirable, but it is obviously equally desirable that when it is provided for it should be built rightly. In too many cases the base is first laid and allowed to set. Then concrete for a curb perhaps 4 in. wide and the depth of the asphalt wearing surface is placed between boards and trowel finished. This is decidedly the wrong way to go about the making of a curb capable of protecting the edges of a road upon which teams are constantly turning out. As a matter of fact, such curbing can usually be kicked out of place, and it is eventually broken off even where much of it is left intact by the roller compressing the asphalt top.

The only way in which substantial curb construction can be secured is by casting the curb integrally with the base. It costs no more to do the work this way and it is useless to do it any other way. Either wood or metal forms may be used, but the latter are preferable, because they can be easily drawn and spiked down ahead as the work proceeds. After the base proper is laid, but before it has finally set, a wood or metal strip of the desired height of the curb is placed to form the inner edge of the curb, and the concrete therefor is then laid between the outer and inner form pieces. In the half-tone herewith metal forms are being used for the outer side of the curb and base and wooden strips for the inner side of the curb, the latter being tied to the metal plates to prevent displacement of the wooden strips when the curb concrete is placed and tamped.

The simple method here described can, of course, only be followed where concrete base is provided. In the case of resurfacing macadam with new asphalt tops it is very desirable

VIEW SHOWING CASTING CONCRETE CURB INTEGRAL WITH BASE, MONROE-TOLEDO ROAD CONSTRUCTION.

to install concrete curbing even if it is only 10 or 12 in. deep. This not only prevents injury to the edges of the road, but greatly improves its appearance, as compared to the ragged edges so often seen on careless bituminous construction.

The conviction, based upon ample demonstration, that roads are not wearing out nearly so fast as they are breaking down under weight of traffic is largely responsible for the opinion that dependable foundations, preferably concrete, with mixed method asphalt tops, to provide good and cheap wearing surfaces and protect the concrete from cracking and heaving, meet the requirements of present-day traffic weights and at the same time come within reasonable limits of cost.

Relative Bleeding of Rectangular Wood and Kreolite Lug Paving Blocks

Tests were recently made by Clyde T. Morris, professor of civil engineering, Ohio State University, Columbus, to determine the relative bleeding of rectangular blocks and Kreolite lug wood paving blocks when submitted to the same pressure under equal conditions.

Data observed in the tests show that if the blocks expand 0.2 in. each, the rectangular blocks exert a lateral pressure of 415 lbs. per sq. in., while the lug blocks exert a pressure of

only 125 lbs. per sq. in. Likewise, for the same amount of expansion, the rectangular blocks bleed three and one-half times as much as the lug blocks.

Six samples of wood block were tested in a Riehle hydraulic machine. The loads were applied in increments of 25 lbs. per sq. in. of block at intervals of one minute. All blocks were tested on the side. Observations were made of the total deformation of the block at each load increment and also the amount of bleeding caused by the pressure.

The oil and water squeezed out was absorbed by blotters and these were weighed before and after the test to determine the amount of oil lost by the block at the various pressures. The areas of the bleeding were determined from the imprint left on the blotters.

Prevention of Bleeding

An authority on wood block paving states that by using open joint construction with blocks laid upon a mortar cushion, bleeding may be almost entirely prevented. About ½-in. of sand should first be swept into the interstices between the blocks to serve as a dam to prevent the possible floating of the blocks. A squeegee coating of pitch should then be applied to the surface of the blocks to fill the spaces to within about 1 or 1½ ins. from the surface of the pavement; the remaining portions of joints should then be filled with sharp pea gravel, or slag sand, and at the same time a top dressing of the same material to a depth of ½ in. left over the surface for traffic to work into the upper fibers of the wood and thoroughly into spaces between blocks.

This style of construction has been called open joint "Pitch-Wich" construction—a little sand, pitch and then more sand, making the resultant surface entirely waterproof. As blocks expand pitch will not be oozed from spaces between blocks; as the wood swells, sand will be forced from spaces instead of pitch.

This method of construction has been used successfully on such prominent thoroughfares as Sixth street, Cincinnati; Vine street, Cincinnati, and Euclid avenue, Cleveland, Ohio, with no bleeding as the result.

The Recent Revision of Ideas About Brick Pavement Construction

Methods of building brick roads have undergone radical changes during the past two years. Types of construction have changed and fundamental ideas have been revised. Two distinct advantages have resulted: Better roads are being built and with less material than the old types required.

Passing of the Cushion.

Formerly a sand cushion between the artificial foundation and the brick surfacing was considered necessary in order to afford an even bearing surface for the brick and to give the resilience theoretically assumed to be required for absorbing and distributing the shock of traffic. Formerly, also, the artificial foundation was regarded as the chief factor in the load-bearing strength of the pavement. Experience and experimental tests have demonstrated the fallacy of both theories.

The rigid type of construction, in which the brick surfacing and the artificial foundation are united in a single beam, has doomed the sand cushion to the discard. It is now known that the brick surfacing, if properly bonded with cement-grout filler, is the real load-bearing part of the pavement, and that the chief function of the artificial foundation is to afford a stable, even bearing for the brick.

The State Highway Department of Illinois has laid a considerable mileage of brick on a 1-in. concrete foundation. Many engineers are constructing brick roads with concrete foundations 2 in. and 3 in. deep, instead of 6 in., as formerly. In other instances 1 in. of cement-sand mortar is used as a bed over old macadam or on gravel soil or road.

Monolithic Brick Pavements.

Of course, in every case in which a shallow concrete foundation is used, the monolithic type of construction is employed. The brick are laid in the wet concrete and are bonded with cement grout filler.

Experiments conducted during the year 1916 to determine the relative resistance to load stresses of brick surfacing and concrete foundations disclosed that with monolithic construction the brick actually lend strength to the foundation, and so also was revealed the fact that the brick hold the concrete foundation so firmly that the expansion and contraction of the latter coincided with the expansion and contraction of the brick, altho when experimented with separately concrete and brick showed marked variations in expansive ranges under heat and moisture influences.

Doubtless the fact that concrete foundations are protected from heat and moisture by the brick surfacing accounts in great measure for the equalizing of the respective coefficients of expansion under the practical conditions established by pavement construction; but the assertion, based upon a series of experiments conducted under the most careful safeguards, that in the brick surfacing resides the main load-resisting strength of a pavement, confirms the contention of proponents of rigid brick pavements that such pavements are the strongest general purpose pavements that can be constructed.

The virtual invulnerability of vitrified brick to abrasion and moisture was already established by the history of hundreds of brick pavements, but until recently the need of a deep foundation was generally conceded.

Now that laboratory tests and practical service tests have proven that a 4-in. green concrete foundation, with a 4-in. vitrified brick surfacing, give a much stronger pavement than was formerly obtained by the use of a 6-in. concrete foundation, a 1½-in. sand cushion and a 4-in. brick top, the cost of brick pavements, allowing for no change in cost of labor and materials, is materially reduced.

The reduction in cost is made greater by the fact that monolithic construction of high ays eliminates flush side edgings and curbs, while the rapic y with which monolithic pavements can be constructed effects an additional saving in the item of labor costs.

In many instances a 3-in. brick of the wire-cut lug type, instead of a standard 4-in. wire-cut lug brick, is used on a 4-in. green concrete foundation, or upon a 4-in. set-up foundation with a 1-in. cement-sand bed for a superfoundation, which binds the brick to the foundation and makes the pavement a single rigid beam from surface to sub-base or natural soil. These brick are used because of their superior bonding strength and square edges.

Advantages of Monolithic Pavements.

The monolithic and semi-monolithic types of pavement—as the green concrete foundation and the cement-sand bed types are called, respectively—are solid, practically noiseless, smooth, sanitary and durable. They originate no dust or dirt, are easily cleaned, and are not in any way affected by motor-vehicle, iron-tired vehicle traffic, or by surface moisture. A well-constructed brick pavement of either type neither becomes wavy nor slippery, nor pits, ruts, ravels nor disintegrates. It remains smooth and even on the surface and is good for all kinds of traffic.

Monolithic brick pavements are now used almost exclusively for brick highways in several states, including the states of Indiana and Illinois. The principle of the rigid beam from surface to sub-base has been found scientifically sound and advantageous from the construction standpoint.

An additional advantage is that inasmuch as all phases of the work are going on at the same time within a distance of 50 ft., the engineer in charge can have all the work under his eye at all times. The contractor also can bring his organiza-

tion to a high state of efficiency by concentrating and systematizing his work and by saving the time ordinarily required in going from one part of the work to another. In fact, the contractor, having all the work under his immediate supervision virtually at a single point, can very easily dispense with a foreman, provided that the contractor is able to devote all his time to the job in hand.

VIEWS SHOWING CONSTRUCTION OF WIRE-CUT LUG MONOLITHIC BRICK HIGHWAY, EDGAR COUNTY, ILL.

In the South, notably in Florida, where the sand drains easily and can be compacted solidly by puddling, more than 100 miles of highways have been constructed with grouted wire-cut lug brick laid on a natural soil foundation. In these cases the monolithic brick slab has proven entirely adequate to sustain regular auto-truck traffic.

This object lesson gives additional confirmation to the opinion that, given a stable, even-bearing foundation, either artificial or natural soil, a well-bonded and smooth brick surfacing is the prime factor in the load-bearing capacity of a brick pavement.

Construction Features of Monolithic Pavements.

The constructional features of a monolithic pavement are a wet concrete foundation reduced to a true cross-section, upon which the brick are laid and immediately rolled, culled and grouted. The object is to obtain a single rigid beam, all parts of which are strongly united. In order to attain that end it is necessary to grout the pavement immediately after laying and rolling the brick, so that the grout filler, going to the bottom of the joints, shall form a homogeneous union with the green concrete foundation.

An essential feature, but one not always regarded in practice, is sprinkling the grouted pavement and keeping it covered with earth or straw for two or three days, so that the grout filler will not set too quickly and crumble.

Of course, as the concrete foundation is green, it is not feasible to use a heavy self-propelling roller for rolling the brick. A twin-cylinder hand roller, about 30 in. long, and weighing, when filled with water, about 800 lbs., gives the best results.

The green concrete foundation is brought to a true contour with either smoothing template or a tamping template designed especially for the purpose. Care must be taken in getting the surface of the foundation to the true contour of the surface of the completed pavement and at the right uniform depth below the surface contour. Care must also be exercised in assuring complete penetration of the grout to all parts of the joint and to the bottom of the brick, as strong bonding together of the brick and of the brick to the foundation are absolutely essential to good construction.

The foundation should be of proper consistency to bear up the brick when they are rolled, yet the moisture content should be sufficient to allow of easy shaping of the surface and to assure a perfect union with the brick surfacing. A foundation too dry is difficult to shape smoothly and it is liable to contain voids and lack uniform density.

No arbitrary rules can be laid down for mixing the concrete for the foundation. Each engineer must exercise discretion in the use of water, so that the concrete shall be of the proper consistency. A little experience or close observation will enable the engineer to fix the amount of water to use; but one detail cannot be neglected: The concrete must not be carried in a barrow for dumping; it must be put in place with the least possible chance for separation of the components.

Owing to conditions produced by the war it is not practicable to give reliable cost data for monolithic brick pavements. The length of hauls, the prices of materials and the price and available supply of labor are so unstable and they vary so much at different points, that estimates made for one point or for one period of time may not be serviceable at other points or at other times.

Quantitative Data.

Quantitative estimates are all that can be made with confidence at this time.

Wire-cut lug brick lay 40 to the sq. yd., or 25 sq. yds. to the thousand. Assuming that a 4-in. concrete foundation mixed 1:3:6 is designed, approximately 0.123 of a barrel of cement would be required per sq. yd. For grouting, 1 to 1 mixture, the requirement per sq. yd. is 0.037 of a barrel of cement. For a sand-cement bed, 1 in. thick, 1 to 4 mixture, designed for semi-monolithic pavement, 0.051 of a barrel of cement is used per sq. yd. The cost of sand or gravel depends upon the proximity of the supply and local market quotations.

There is a tendency on the part of some engineers to use a stronger mixture for both foundation and cement-sand beds, 1:2½:5 for the former and 1:3 for the latter. In that case it would require 0.144 of a barrel of cement per sq. yd. for the base and 0.065 of a barrel of cement per sq. yd. of area for cement-sand bed 1 in. deep.

Sewer Design and Construction

Features of Sewer Construction Work at Elmhurst, Ill., and South Bend, Ind., Using Lock Joint Sewer Tile

Two interesting sewer construction jobs in which Lock Joint Sewer Tile are employed are under way at Elmhurst, Ill., and South Bend, Ind., respectively. At Elmhurst there are 2,690 ft. of 42-in. sewer in an average cut of 17 ft., and 4,660 ft. of 36-in. sewer in an average cut of 14 ft. There are also about six miles of clay pipe sewer ranging from 24 in. in diameter down to 6 in.

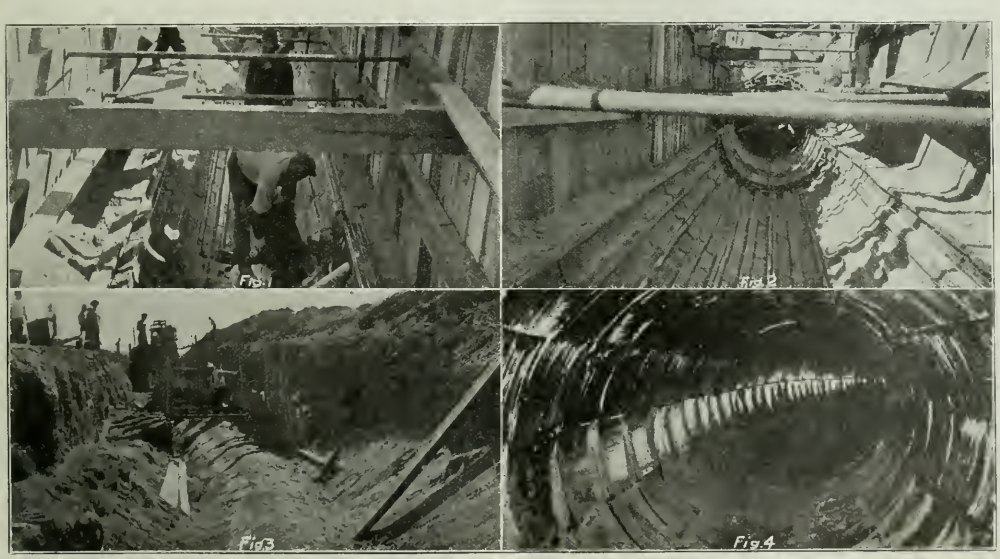
The Elmhurst Job

A Parson's excavating machine is employed to cut the trench for the block sewer. It will cut 72 ins. wide, but is set to cut a 66-in. trench on the 42-in. sewer and a 60-in. trench on the 36-in. sewer. An Austin "O" excavator is used in trenching for the tile pipe sewers. Brick manholes are located in the line about 260 ft. apart. The tile pipe sewer trenches are back filled with an Austin gasoline backfiller and the block sewer trenches are back filled with a Parson's gasoline power backfiller.

The work on the Elmhurst job started March 5 and will end early in October. At the time of beginning the work there was 3 ft. of frost in the ground and it was found that the machine would cut through only 18 ins. of frost, so the contractor waited for a thaw before proceeding with the work.

The soil consists mostly of clay. A stretch of quicksand 1,000 ft. long in a 25-ft. cut was encountered on the 42-in. line. In the quicksand the excavation was kept down to a depth of 18 ft. with the machine and the trench was sheeted solid to a depth of 20 ft. below the surface. The remaining 2 ft. of clay and 3 ft. of quicksand were taken out by hand in buckets of ½ barrel capacity pulled up by windlasses.

A great deal of trouble was experienced with the sheeting on account of the weight of the excavating machine, the deep cut and the underlying quicksand. Wood stringers and iron extension sewer braces were used exclusively in bracing the trench. The iron braces were set at the corners of 5-ft. squares. The sheeting was of 2-in. planking, 20 ft. long, and was put in by hand. To unwater the trench a pulsometer pump was employed, using steam taken off of the boiler on the Parson's excavator. Two gasoline trench pumps were also employed on this work.



VIEWS OF SEWER CONSTRUCTION AT SOUTH BEND, IND., USING LOCK JOINT SEWER TILE.

Fig. 1.—Laying the invert; two courses of block with ¼-in. bed of 1:2 mortar between. Fig. 2—Crown and form for springing the arch. Fig. 3—Typical view of curve. Fig. 4—Interior view of curve before joints were pointed or sewer cleaned out.

The average rate of progress on the 42-in. sewer was 30 ft. of completed sewer a day. The organization of the contractor's forces at Elmhurst was as follows:

Two men laying block (1 invert, 1 crown), 1 man tending masons, 2 men lowering blocks, 2 men carrying blocks and mortar, 1 man mixing mortar (1 to 1 mix).

The men laying the sewer blocks were paid 40c an hour and common labor on the job was paid 30c an hour. The force worked 10 hours a day.

One engineer and one fireman were regularly employed on the machine. Altogether there were 17 men in the construction crew. In addition to those enumerated there was a crew on the sheeting work and one trimming the bottom of the trench to the size and shape of the outside diameter of the sewer. The contractor and one foreman were in charge of the

work. The contractor on this job was Henry Reese of Quincy, Ill. Warton Platner of Chicago, was consulting engineer.

The best day's work on the 42-in. sewer was 86 ft. In the quicksand section the progress was about 14 or 15 ft. a day. This work was done in rainy weather.

The line of the sewer contains three curves, one of a 20-ft. radius and the other two of 50-ft. radii. In going around the sharp curve half blocks were used on the inside of the sewer and thin joints were used and a neat job realized.

In laying the lower half of the sewer a steel template was placed for every course of blocks. Wood center forms running inside of the completed lower half formed the frame for turning the crown on the sewer. The steel template consisted of a steel angle iron bent to the diameter of the outside of the sewer and braced across the top so that it could not spread. This held the blocks in place until back-filling around them had been completed. This back-filling was done as soon as possible as the work progressed. After one course was thus back-filled the template was shifted to the next course.

About 300 ft. of rock was encountered in the 42-in. sewer which was blasted out with dynamite. Air was piped from a stone quarry compressing plant about two blocks away and used to operate the air drills. A good deal of rock was encountered on the pipe sewers.

On the 36-in. sewer the progress ranged from 40 to 120 ft. per day in good ground. The average on this sewer was 80 ft. per day.

The specifications drawn up to govern the bidding on this job included all makes of vitrified block. The contract was awarded to the National Fire Proofing Company of Pittsburgh. Under the Illinois law governing local improvements, only one material can be specified on special assessment work. O. H. Stange is chairman of public works in Elmhurst and was inspector on this job.

The South Bend Job

The work at South Bend consists of 2,380 ft. of 5-ft. sewer in an average cut of 14 ft.; 1,250 feet of 54-in. sewer in an average cut of 12 ft., and a small amount of 36-in. sewer at a road crossing.

The specifications under which bids for material were received included all makes of blocks and reinforced concrete pipe. The bid on the blocks was $13.48 per ft. of completed sewer and that on the concrete pipe was $13.45 on the 5-ft. sewer. On the 54-in. sewer the bid on the concrete pipe was $12.30 per ft. of completed sewer and on the vitrified block $12.35. The vitrified block proposal was accepted and the block was furnished again by the National Fire Proofing Company of Pittsburgh.

At South Bend the soil encountered was sand and gravel on the 60-in. line and sand and clay on the 54-in. At the outfall of the sewer 200 ft. of the line passed through low land adjacent to the river. Here water in the trench was encountered and one gasoline pump was used to unwater this trench. The cut here was only 2 ft. deep and the sewer was later covered with 8 ft. of sand covering. The contractor on this job is the National Company of South Bend, with George Harrop in charge. F. Anderson is city engineer.

The trench was excavated by an Austin gasoline excavating machine cutting a trench 42 ins. wide. Workmen spudded in the bank by hand to a width of 75 ins. Four men were employed on this work all the time. The bank was broken in and the earth thrown within reach of the excavator. On this job there were employed 1 foreman, 1 superintendent, 1 engineer on the machine, 2 block layers, 2 helpers, 2 men lowering and carrying blocks, 1 mixing mortar, 1 wheeling mortar, 4 men sheeting and 4 men shaping the trench bottom to the proper diameter and shoveling into buckets and throwing dirt into the excavator. The block layers in this case were brick layers and were paid 65c per hour. The other labor was paid 35c per hour and a ten-hour day was in force.

A cable way was used in cutting down a bluff where the cut reached a total depth of 32 feet. At this point the sewer had a rise of 1 ft. in 10 for a distance of 100 ft. This bluff was at the edge of the bottom land previously mentioned, adjacent to the St. Joe river.

The best day's work on the 60-in. sewer was 75 feet of completed sewer. At the time of writing, no 54-in. sewer has been laid. The work at South Bend started on July 10 and will probably be finished by November 1.

The South Bend sewer line contains a good many compound curves. The sharpest curve is of a 50-ft. radius. Full sized blocks were used in going around these curves but the joints were made thin on the inside so as to produce a smooth job.

On the South Bend work a wood template was set 30 ft. ahead and guide lines stretched for the invert. The crown was set on a 15-ft. wood form, mounted on wheels to run ahead on the lower completed half of the sewer, upon which to turn the arch. The trench was shaped to the true diameter of the sewer by hand. Some sheeting in deep cut was done by hand. A gasoline back-filler was used on all South Bend trenches.

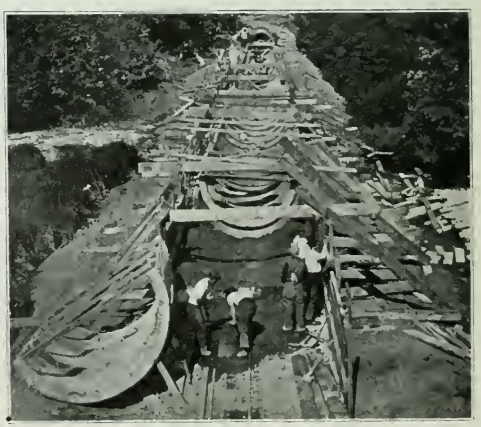
The South Bend sewer is a combined trunk sewer and has a 6-in. connection every 60 ft. Brick manholes are 300 ft. apart on the line. Mr. R. B. Peters of the Chicago office of the National Fire Proofing Company sold both of these jobs and looked after construction. We are indebted to him for the photographs shown herewith.

Construction Plant and Methods Employed in Building the Woodville Avenue Sewer, Toronto, Ont.

The Woodville avenue sewer, in the city of Toronto, Ont., is 5,780 ft. long and is 8 ft. in diameter. The first 240 ft. of the sewer was built on bents, the next 1,650 ft. were built in open cut and the last 3,890 ft. in tunnel. The construction methods employed on these three sections are here described.

The Section on Bents

The shallow ravine which necessitated these 240 ft. of bents is the bed of a creek which in former times was much



CONSTRUCTION VIEW ON OPEN CUT SECTION, WOODVILLE AVE. SEWER, TORONTO.

larger but is now contained in a 3-ft. concrete pipe which terminated at Conduit street at the time when the construction of the Woodville avenue sewer was begun. At that time the

pipe was extended and the ravine was afterwards filled in where Woodville avenue crosses it, with surplus material taken from the sewer excavation. This filling provided both the roadway and a future foundation for the sewer when the bents will have decayed. As in the case of Clendenan avenue, pipes were left through the bottom of the sewer through which sand was later run to fill the space left by shrinkage.

An excavation 3 ft. deep was made across this ravine to obtain a solid foundation for the timber bents. In the center and low part of the ravine, the ground for 30 ft. was rather soft and on this account a 3-in. plank decking, placed lengthwise of the sewer with broken butt joints was provided for the sills to rest upon. Throughout the remainder of this excavation the sills rested on the ground. The bents were 5 ft. apart between centers. The sills are 10x12-in., five vertical 10x10-in. posts, 2-ft. 6-in. centers rest on each of these sills and are let into them 1 inch, and are held apart by light 2x8-in. straps. There is an 8x6-in. runner placed lengthwise with the sewer at the top of each row of posts and let into the sides of the posts 3 inches. A 3-in. decking is then placed over all, leaving the tops of the posts exposed.

The sewer in this section is culvert-shaped outside with a semi-circular top, while the inside is circular. The crown and invert of the sewer are built of reinforced concrete with a half ring of paving brick in the invert for a wearing surface. The concrete in the bottom is 1:2:4 mix and is provided with a layer of 0.3 sq. in. per square foot mesh 2 in. from the bottom. At the springing line of the arch the concrete is 18 ins. thick and gradually reduces to 12 ins. thick in the crown. Two layers of mesh of the same weight as used in the invert are used in the crown, one near the outside and the other near the inside. The outside layer extends around the top and down the side walls to the flow line, while the inner layer extends only to the springing line of the arch.

The Section in Open Cut

The part of this section as far as Humberside avenue was at an average depth of 22 ft. and was built of three rings of brick. At this point, a 4-ft. ramp was provided, but in spite of this, the average depth from Humberside avenue to Annette street was 29 ft. and this part was built of four rings of brick. At Annette street, another 4-ft. ramp was provided. From Conduit street Humberside avenue the grade is 1 ft. in 185 ft. Two lateral sewers, a 12-in. and a 15-in., are picked up. From Humberside avenue to Annette street the grade is 1 ft. in 195 ft. At Annette street a chamber was designed to pick up five laterals, a 12-in. and a 24-in. pipe, a 2-ft. x 3-ft. and a 2-ft. x 4-ft. (all brick.)

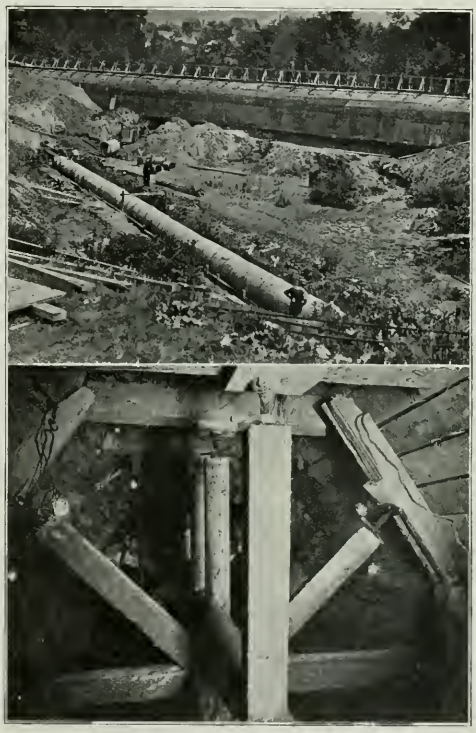
Cableway

As an aid to handling the material from this excavation a cableway 250-ft. in length was provided. The excavated material was raised from the bottom of the trench in ½ cu. yd. buckets by the cableway and carried to the rear, part to be used as back-fill over the completed sewer, and the rest to be hauled in wagons to the nearby ravine. At first, the bottom of the excavated trench was dry and the work proceeded rapidly, but as the trench was continued northerly and became deeper, the bottom became soft and wet. It was necessary then to square the bottom and use decking. This extra labor of course delayed the work, but it was, nevertheless, well managed and quickly accomplished. The bricks were hauled to the job in wagons and piled along the trench, whence they were lowered as required in iron backets, each holding about twenty bricks.

North of Humberside avenue, the contractor intended to construct the sewer in tunnel, but the ground was found to be too wet for tunneling without the aid of compressed air. It was found, after investigation, that this could not be economicaly used for two reasons. One was the presence of a badly cracked old storm sewer about 5 ft. above the crown, and the other was the fact that about 10 ft. or 12 ft. of the ground on the surface was filled, and therefore of a loose nature. The open cut was accordingly continued to Annette street.

Tunnel Section

A total of 3,890 ft. of this sewer were planned to be built in tunnel. It was now certain that the ground would be very wet. This had been suspected from borings taken, but it was thought that these might indicate merely a local condition.



UPPER—VIEW OF 8-FT. AND 3-FT. CONCRETE SEWERS, TORONTO. LOWER—NEEDLE BEAM METHOD OF SUPPORTING SHEETING IN TUNNEL SECTION.

Accordingly, it was decided that compressed air would be necessary to drive out the water and a pair of compressed air pumps of 1,000 cu. ft. capacity were provided and a plant erected. It was later found that these two pumps did not supply sufficient pressure and a third and later a fourth were added to the plant. South of the C. P. R. tracks, an open cut 70 ft. long was made for locks and shaft. When the locks were built, a hollow wedge of timbers was forced over them into the solid earth at each end of the open cut. This wedge was filled with concrete and served to seal up the broken strata at and over the ends of the lot, and so help to prevent the escape of air. A shaft was timbered up midway between the two lots, and the remainder of the open cut back-filled. A head-frame was then built over the top of the shaft and a rough skip, with guides on two sides, was used for raising and lowering surplus and building material. The proximity of a C. P. R. siding was a convenience in handling material. Bricks, cement, timber, etc., were unloaded into the sheds there and carried to the shaft in small cars as required. Tunnelling was proceeded with in both directions simultaneously, but work had to be suspended in the north tunnel because it was

found that all the air available at the time was needed in the south tunnel.

South Tunnel

Work in this direction went well for a time but was delayed on several occasions by the escape of the air into an old local sewer overhead. The joints in this sewer were very imperfectly made and in a number of cases the pipes were cracked. The escaping air carried the supporting earth into the old sewer in such quantities that it collapsed and had to be rebuilt before work could be carried on underneath. At Dundas street the worst of these breaks occurred under the street railway tracks and for a few days the street cars had to turn back at this point instead of at Keele street. Repairs were made by open cutting and supporting the tracks with heavy timbers. When this point was successfully passed, the work went smoothly for a time. However, the overhead cover of earth was now becoming less and it was increasingly difficult to contain enough pressure in the tunnel. When, added to this, defects in another old overhead sewer were encountered, tunnelling had to be abanded and the old sewer had to be moved to one side and rebuilt. A test hole was made to prove the exact location of the eend of the tunnel. The cableway was again set up and an open cut 360 ft. long was proceeded with. Here it was necessary to use heavier timber than was used in the other open cut since the sewer made a slight bend at this point, which brought it close to the houses on the street. Since the bottom of the trench here was very wet and the ground running sand, besides putting heavier timber in the work the contractors cut holes in the brick work foundations of the buildings and inserted under them heavy timbers which were held in place with jacks. Every day levels were taken and if the timbers showed any sign of settlement, the jacks were tightened. This work was given such good and close attention that when the open cut was complete and the back-fill made the buildings showed not the least sign of settlement. The holes were then filled up and everything left as formerly. The sewer was now complete as far north as the shaft at the tracks.

North Tunnel

When work was resumed on north tunnel all the air from the two pumps was turned into it. But very soon this was found to be insufficient, and it was at this point that the third and then the fourth pumps were added to the plant. The addition of a fifth was considered, but it was decided that the four pumps were supplying as great a pressure as the ground conditions would permit. Progress was very slow, averaging only 2 or 3 ft. per day.

Difficulties Encountered

The worst difficulties were encountered under the C. P. R. tracks, where the natural strata of the earth had been broken up by the constant pounding and vibration caused by the heavy engines and trains. Work had to be suspended and the air turned off, sometimes every other day, to allow the ground to settle and consolidate. Every scheme that could be thought of was used to assist in this consolidation. The surface was soaked constantly with water, sand was brought and washed into the ground, sand bags were heaped up between the tracks to hold the ground down when the pressure was on in the tunnel, and grout was pumped into the earth from the surface and through the brick work of the sewer. At this time blow-holes could be seen all over the surface of the ground above the tunnel. These were sometimes so large that the end of a pick handle could be shoved into them and the sand blown therefrom would rise six or seven inches from the mouth of the hole. At some distances from the center line of the tunnel the surface of the ground looked as though it was covered with small ant-hills and the sand was constantly in motion. The greatest pressure that could be used was twenty-six pounds, which was often barely sufficient to dry the ground. The bottom foot or two of the excavation was frequently wet and sometimes took as long to prepare and remove as the 10 or 11 ft. above.

When the heading got so far away from the shaft that it was no longer economical to use man power on the construction cars, mules were introduced to do this work. Two cars were hitched together and one mule would draw them. The mules, however, did not like the compressed air any too well and when first introduced to it raised considerable objection.

After the Canadian Pacific Railway tracks were passed the work continued fairly regularly until Mulock avenue was reached, where an old local sewer again gave trouble. This was a tile-pipe sewer with joints so imperfectly made that the air escaped into it in ever-increasing quantity until it was found impossible to contain enough pressure to hold back the water. It was then decided that the old sewer would have to be plugged and a new local was built along each boulevard. Every effort had been made to avoid doing this; the contractors even hauled earth from the south side of the tracks (about one-quarter mile) and deposited it on the street to a depth of two or three feet, also a new lock was built near the heading which would reduce the volume of air and, therefore, the area for possible escape. The compressors were also moved up and pipes driven from the surface through which the air was pumped into the tunnel. But all these efforts proved of no avail and the new locals had to be built.

Advantage was taken of this delay to test the line of the sewer. This was considered advisable since the line had been carried around three curves from the shaft south of the tracks where it was first taken down. Two 6-in. pipes covered by caps were driven from the surface of the ground on the correct line ahead of the work. When these were driven to a sufficient depth plumb lines were dropped to the bottom, the top ends of which were placed exactly on the correct line of the sewer. Afterwards, when the tunnel reached these points, the resident engineer found to his satisfaction that his line was almost exactly true.

While the new locals were being built, a new shaft was sunk at a point on Mulock avenue, north of Hirons street. Another lock was also built and in this case a concrete collar was provided to prevent the air from escaping back over the lock and into the shaft. The shorter haul more than compensated for the cost of sinking the shaft. Work from here went on rather quickly and without any more accident. Toward the end of this section the greatest progress was reached, from 12 to 15 ft. of sewer being completed each day.

The needle-beam method of supporting the timbers was used throughout. Several of these beams broke, owing to the various accidents which lessened the air pressure in the tunnel and thus necessarily increased the weight on the beams. After each accident the size of the needle-beam was increased, until a 16 by 16-in. timber, reinforced on each side with steel plates, was used. Several times when the pressure was decreased the timbers in the crown of the tunnel settled so much that there was room only for one or two rings of brick. These places were built in temporarily, but when the rest of the sewer was complete they were opened up again, the timber raised and the brick work replaced correctly.

Considering the whole work, with the many difficulties overcome, the contractors, Messrs. Donnelly & Graham, deserve great credit for their spirit and perseverance.

The data here given were reported to the Canadian Engineer by W. G. Cameron, District Engineer, Sewer Section, Department of Works, Toronto, and Mr. Cameron furnished Municipal Engineering the views shown herewith.

Recommended Practice for Laying Sewer Pipe

A proposed revised tentative recommended practice for laying sewer pipe formed an important part of the report of Committee C-4 of the American Society for Testing Materials at the recent annual convention. The editor is advised by Edgar Marburg, secretary-treasurer of the society, that the recommendations were accepted by the society for publication among the tentative standards of the society, and it is probable they will be recommended for adoption as standard next year. The committee consists of 19 members. Rudolph Hering, consulting engineer, is chairman; A. J. Provost, Jr., consulting engineer, vice-chairman, and E. J. Fort of the Brooklyn sewer department is secretary. Pending the adoption of the recommendations as standard, engineers may safely regard them as indicative of the best practice in laying pipe sewers.

Preparing Trenches and Foundations for Pipe Laying

The foundations in the trench should be formed to prevent any subsequent settlement and thereby possibly an excessive pressure and consequent rupture of the pipes.

If the foundation is rock an equalizing bed of concrete or sand well compacted should be placed upon the rock. The thickness of these beds should not be less than 4 ins. Pipes should be laid in these beds so that at least the lower third of each pipe is supported its entire length.

If the foundation is good firm earth, the earth should be pared or molded to give a full support to the lower third of each pipe and, if necessary to secure proper bearing for the pipe, a layer of concrete, fine gravel or other suitable material should be placed. The same means of securing a firm foundation should be adopted in case the excavation has been made deeper than necessary.

If there is no good natural foundation, the pipes should be laid in a concrete cradle supported on a masonry foundation carried to a soil of satisfactory bearing power or supported on a structure designed to carry the weight of pipe and its load to a firm bearing.

Trenches should be kept free from water until the material in the joints and masonry has sufficiently hardened.

To protect pipe lines from unusual stresses all work should preferably be done in open trenches.

Pipe lines should be placed at a sufficient depth below the surface of the street to avoid dangerous pressure or impact. When this is not possible special reinforcement should be provided.

Trenches should be only of sufficient width to provide a free working space on each side of the pipe, according to the size of the pipe and the character of the ground, but in every case there should be sufficient space between the pipe and the sides of the trench to make it possible thoroughly to ram the backfilling around the pipe and to secure tight joints.

Pipe Laying.

The laying of pipes in finished trenches should be commenced at the lowest point, so that the spigot ends point in the direction of flow.

All pipes should be laid with ends abutting and true to line and grade. They should be fitted and matched so that when laid in the work they will form a sewer with a smooth and uniform invert.

It is necessary to use all possible care when shoving the pipes together, so that the joints will not be unnecesarily large.

Bells should be carefully cleaned before pipes are lowered into trenches. The pipes should be so lowered as to avoid unnecessary handling in the trench.

The pipes should be set firmly accordingly to line and grade, and the joints carefully adjusted and filled with the jointing material.

Joints should be made in the following manner: A closely twisted hemp or oakum gasket of suitable diameter, in no case less than ¾ in., and in one piece of sufficient length to pass around the pipe and lap at the top, should be solidly rammed into the annular spaces between the pipes with a suitable calking tool. When cement joints are used, the gasket should first be saturated with neat cement grout. The remainder of the space should then be completely filled with the jointing materials.

Back-Filling Trenches.

All trenches and excavations should be back-filled immediately after the pipes are laid therein, unless other protection of the pipe line is directed. The back-filling material should be selected and deposited with special reference to the future safety of the pipes. Clean earth, sand or rock dust should be solidly tamped about the pipes up to a level at least 2 ft. above the top of the pipes. This material should be carefully deposited in uniform layers. Unless otherwise permitted, each layer should be carefully and solidly tamped or rammed with proper tools so as not to injure or disturb the pipe line.

Puddling or water flooding for consolidating the backfilling is recommended only for sandy and gravelly materials. If this method is used, the first flooding should be applied after the back-filling has been compacted by tamping up to 2 ft. above the top of the pipes, and the second flooding during or after the subsequent filling of the trench. An excess of water should be avoided, in order to prevent disturbance of the earth under and around the pipes and also to prevent an undue excess of pressure upon them.

Walking or working on the completed sewer, except as may be necessary in tamping or back-filling, should not be permitted until the trench has been back-filled to a height of at least 2 ft. over the top of the pipes.

The filling of the trench should be carried on simultaneously on both sides of the pipes in such a manner that injurious side pressures do not occur.

Cost and Efficiency Comparison of Motor Trucking and Horse Haulage

In an investigation conducted at Bennington, Vt., it was found that H. W. Meyers & Son, dealers in coal and feed, have been effecting a saving of $11 a day in employing a two-ton Federal truck for making their deliveries.

This information was gained through accurate records of horse and truck operations covering a period of six months. It was further shown by these records that the Federal two-ton truck had performed 350 per cent more work than any of the firm's teams on the same type of deliveries. This has been accomplished at an additional cost of but 20 per cent over the expense of two horses.

Taking these figures as a basis, a two-ton truck performs the work of 3½ teams. The cost of the horses is figured at $178.13 a month, or $5.93 per day. Three and a half teams would cost $20.77 per day. The monthly cost of truck operation is put at $213.17, or $7.10 per day. Even including the wages of a helper on the truck this form of transportation would be $11 a day cheaper than by the use of teams for the same work.

Concreting in Cold Weather

Only a few years ago many contractors and other concrete workers thought it necessary to stop concrete work with the approach of cold weather. Today cold-weather concreting practice has become so standardized that in most localities concreting is carried on throughout the entire year. Protection of concrete work done in cold weather requires that means be used to duplicate summer temperature conditions in the concrete itself. This is done by heating all the materials, although there are occasions when only the mixing water need be heated.

Pavement Cleaning and Maintenance

The Importance of Proper Maintenance of Country Roads

By J. D. Fauntleroy, District Engineer, United States Office of Public Roads.

Before building a road we should look ahead, past the construction period to the maintenance which is to follow after, and endeavor to get a mental vision of how that road should look two or three or ten years hence. This is not a matter of mere conjecture, but, from information in hand, knowing the traffic that will traverse a road, we can determine, within reasonable limits, what the life of any particular class of road will be, and can also in like manner determine what the cost of maintaining that road should be. With such knowledge available it is criminal folly to go ahead and construct roads that will not answer the traffic requirements and that will either fail utterly, leaving only the debt to show that they were once constructed, or else they will have to be, at a future date, reconstructed at a much higher cost than would be the case had they been properly constructed of suitable materials in the first place.

The Perfect Maintenance System Not Yet Found.

The question of maintenance is an old one. For the past 25 years different states have been experimenting and passing laws in the hope of successfully solving this problem. It cannot be said that any state so far has developed a perfect system of maintenance. We know that in certain sections of a state, for example, the roads will be better maintained than in other sections, and the only way we can account for it is that in some counties the men in charge of the road work are more conscientious and develop more efficient methods than the road supervisors in other counties.

I know a county in Texas which, without the aid of any bond issues, has succeeded in putting its main roads in very creditable condition, because its road overseers have tried honestly and faithfully to make every dollar go as far as possible, and have tried to handle the road business as though it were their own private enterprise. Very close to this county is another county, wherein all of the road funds have been expended and over $100,000 of "anticipation warrants" have been issued for the purpose of road improvement, and the roads are in a most wretched shape. This indicates indifference and neglect on the part of the officials of that county.

Personal Interest All-Important in Road Maintenance

I do not know of any business wherein personal interest and intelligence will count for more than in the maintenance of rural roads. Take, for example, the dragging of roads. Some men will take a road machine or a light drag and go out over a road during a rain or immediately after it, and in the course of a few hours it will look splendid, with the ditches cleaned out and the crown properly shaped. On the contrary, many men, when employed to drag a road, will defer this very necessary operation until the road is baked hard and dry and ruts are all over it, and as a result dragging is practically useless. You can put it down as a fact that when a man takes the seat off his wagon and places it on the road drag, he is no good as a road man, and to any one who really wants to see a road improved it is exasperating in the extreme to see such a man dragging the road, with the horses going aimlessly ahead, while he dozes contentedly on his seat.

To handle a drag properly and get the best results, a man must be on the alert, stepping from one side of the drag to the other and occasionally getting off, and even lifting one side of the drag in order that he may secure a proper crown to his road.

I know of many cases where the present county funds not only suffice to maintain the roads, but the roads are being gradually improved all the time. I know of an eastern state wherein, by a system of careful maintenance, the unimproved state highways have been turned into very creditable roads, tho no actual construction or reconstruction work has been done. This was done by cutting off a bump here, straightening out a sharp bend there, replacing temporary bridges with permanent drainage structures, and keeping the road well bedded up and thoroughly drained.

On the contrary, I know of a county in west Texas where a road needed only about a half day's work with a road machine to put it in good condition, and a number of road hands proceeded to plow up the entire road, thereby destroying the hard surface which the road had. The result of their three days' work was to utterly ruin one mile of road. It will take fully $500 to put this road back into proper shape.

Good Maintenance Condition Precedent to Federal Aid

On all work where federal aid money is solicited we require resolutions from the local board stating that the road will be maintained, and when I have appeared before such boards and explained that such resolutions must be forthcoming, they have invariably answered me promptly that adequate financial arrangements would be made. I believe it is always better to have a clear understanding beforehand, rather than an unpleasant settlement afterwards, and for this reason I have asked these local boards in just what manner they were going to maintain these roads, and their answers have invariably been that the local road supervisor or overseer would see that the roads were maintained. I have then asked them if this road overseer or road supervisor was a skilled man and if the roads under his charge at the present time were properly maintained. This latter question was generally a facer to them, and they had to acknowledge that their roads were not efficiently maintained. Then I have explained to them that the proper maintenance of a road means the providing of an adequate organization to maintain the road; that some man must be definitely responsible for the road at all times, and that it is much better to have one conscientious man devote his whole time to road work and to know that he has a sure means of livelihood so long as he performs his duties, than to work the road spasmodically with gangs of men who have little interest in such work.

Cantonment Road Building in Record Time

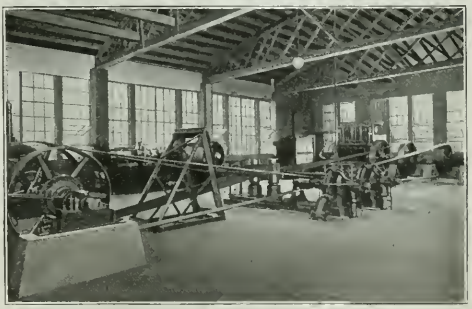
A record-breaking piece of road building was completed recently in connection with the army cantonment near Louisville, Ky. This is one of the few military establishments that have built permanent roads. In 63 working days the contractor completed 63,360 sq. yds. of Trinidad asphaltic concrete highway laid on a concrete base, or about 6 miles of road 18 ft. wide. A mile of the road was over a 4-ft. fill, and immediately upon its completion a traffic count showed that 4,000 vehicles passed over it within the first hour. Most of these vehicles were motor trucks and wagons carrying loads of from one to five tons.

Water Works Design and Construction

Extensive Water Works Reconstruction at Wheaton, Ill.

Reconstruction of the Wheaton, Ill., municipally owned water works system was completed about two months ago. The source of supply is two 10-in. wells, drilled to a depth of approximately 250 ft., penetrating a limestone formation.

These wells are located approximately 30 ft. apart. A dry well was sunk to a depth of approximately 33 ft. below the basement or lower floor level, in which is installed two vertical turbine type American Well Works pumps. The suctions

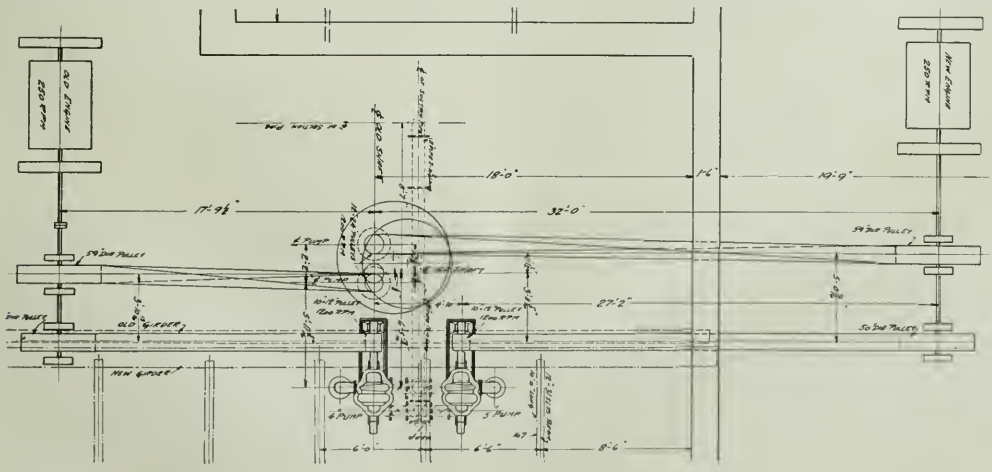


EXTERIOR AND INTERIOR VIEWS OF NEW WATER WORKS PUMPING STATION, WHEATON, ILL.

of these pumps are connected thru tunnels to each of the 10-in. wells. Each pump is provided with all necessary shafting, bearings, etc., together with a steel frame, which is carried to the second floor and fitted with a vertical pulley. One pump is operated thru one-quarter turn belt by a 60-h.p. Nash producer gas engine; the other is operated by a 100-h.p. Nash producer gas engine.

also installed in this plant two "American" horizontal 2-stage diffuser type centrifugal pumps, one designed to have a capacity of 500 g.p.m. when working under a total head of 210 ft. When drawing water from the surface reservoir and discharging into the distributing system and elevated tank this pump is operated by the 60-h.p. engine. The second horizontal pump is designed to have a capacity of 750 g.p.m. when working under a total head of 210 ft.; service is the same as 500-gal. unit. The mechanical efficiency of both of the horizontal pumps is 72 per cent.

In 1912 the city of Wheaton installed the 60-h.p. Nash producer gas engine referred to for operating two centrifugal pumps, one pump being installed in a dry well drawing water



PLAN OF LAYOUT OF NEW PUMPING MACHINERY, WHEATON, ILL.

These pumps deliver water from the wells mentioned to a surface reservoir. Each pump is designed for delivering 750 g.p.m. when working under a total head of 70 ft. When pump is operated at rated capacity 22-in. vacuum is carried. The mechanical efficiency of these pumps is 70 per cent. There is

from the two 10-in. wells, having a capacity of 750 g.p.m. when operating under a total head of 70 ft.; one 2-stage horizontal centrifugal pump, type "K," designed to have a capacity of 500 g.p.m. when operating under a total head of 160 ft., but owing to the increase in population it was found necessary to

increase the capacity of this plant, also to make provision for duplicate equipment. The citizens of this city voted a bond issue of $35,000 for this improvement.

A new elevated tank, having a capacity of 200,000 gals., was installed at a higher elevation than the former standpipe, which has been removed, and two special type vertical pumps

LOOKING DOWN INTO THE 33-FT. PUMP PUT OF THE WHEATON WATER WORKS.

were designed so they could be installed in dry well in place of one. The dry well was not perfectly plump and straight, which necessitated the construction of special equipment, illustrated herewith.

The old steam plant, which formerly had been held as an auxiliary, was removed and a new building of modern design erected, consisting of lower floor or basement, which includes supply room, producer room and coal room. The main floor consists of engine, pump room and office. This plant, from the time first pumps were installed, has not only proven efficient, but absolutely reliable. The daily consumption is 350,000 gals., there being 1,050 service connections.

Joining Cast Iron Water Mains with Cement

Cast lead joints for cast iron water mains have been the regulation type for many years, altho in recent years many miles of big pipe have been pneumatically caulked with lead wool. Latterly cement joints have been successfully employed for this purpose, and approved procedure in this connection was recently described by Clark H. Shaw in a paper before the American Society of Civil Engineers, substantially as follows:

The pipe is placed in the usual manner. A thin backing of the best dry jute is used instead of oakum, as the jute is free from oil and grease, which should be avoided. Portland cement conforming to the specifications advocated by the American Society for Testing Materials is placed dry on a piece of canvas and moistened. When thoroly mixed by hand it should be of such a consistence that when gripped tight it will take the form of the hand and when dropped 12 in. will crumble. The canvas containing the cement is placed under the bell, and the cement tamped into place by hand with a caulking iron until the bell is about half full. It is then caulked with heavy blows until the cement is packed thoroly in the back of the socket. The process is continued until the bell is packed solid. A small bead of cement is then added, the caulking iron being used as a trowel. As soon as the initial set of the cement in the bead has taken place, the joint is covered with earth to protect it from the air and sun.

The bead is regarded as essential because the cement packed in the bell is so dry that without protection it would absorb moisture from the water used in settling the trench. It is believed that, should the joint develop seepage when the main is placed under pressure, the cement, being dry, would expand and aid in keeping the joint tight. The joint is allowed to stand 48 hours before it is placed under pressure and the main put into regular service. Cement joints have, however, been used with satisfactory results 12 hours after completion, but this is not recommended.

At Long Beach, Cal., there are 60 miles of cast iron water mains, ranging from 4 to 24 in. diameter, laid with joints of this type. These mains are under pressures ranging from 40 to 80 lbs. per sq. in., and are giving perfect satisfaction.

Refuse Collection and Disposal

Toronto Incinerator Exceeds Burning Capacity Guarantee by 133 Per Cent

The Don incinerator plant of the city of Toronto was recently completed and is now being operated by the department of street cleaning of which J. A. Burnett is engineer. The building is of fire-proof construction throughout and cost about $200,000. In plan it is 151 ft. by 81½ ft. It has five floors known as the tipping, charging, stoking, main and ash-run floors respectively. Collection wagons are driven directly upon the tipping floor. The charging floor is 9 ft. lower than the tipping floor and is located on the west side of the building, while the tipping floor is on the east side. The main or ground floor is 33 ft. below the tipping floor. Seven feet above the main floor and on the extreme west side of the building is the stoking floor, from which the furnaces are stoked and cleaned. Below the stoking floor is the ash floor, along which the residue from the furnaces is cleaned, as reported by Mr. Burnett in the Contract Record of Toronto.

On the northwest corner of the main building a wing is built which is known as the ash building. This portion of the plant is equipped with a large steel ash bin, suspended from the ground floor into which the residue from the furnaces is discharged; the bin is approximately 10 ft. above ground level, which permits the residue to be loaded into railway cars or team wagons as desired. A railway siding is brought into the plant and passes under and through the ash building.

The plant is equipped with three high temperature Sterling furnaces of modern design which were installed and guaranteed by the Canadian Griscom-Russell Co., Ltd. The furnaces are of the top-fed continuous-grate, regenerative type. They are each constructed with four cells, which are charged and cleaned individually. At the extreme end of the grates a spacious combustion and settling chamber is constructed. The by-pass flue, over which the regenerator chamber is built, completes the furnace construction. An elevated flue connects the furnaces with the main flue which in turn, is connected to the chimney.

High Temperatures Remove Odor

Each furnace has a total area of 100 sq. ft., the cells each containing 25 sq. ft. The guaranteed burning capacity was 50 lbs. of refuse per sq. ft. of grate area per hour, when burning material containing not more than 940 lbs. of water per ton of 2,000 lbs. and not less than 460 lbs. of combustible per ton. The furnaces are designed and constructed for high temperatures, the specified temperature requirements being such that the combustion chamber temperature shall not fall below 1,250 degrees F. for more than three minutes in any one hour, and that an average temperature of at least 1,400 degrees F. be maintained therein. From the requirements it may be readily seen that any objection due to the presence of obnoxious gases is entirely eliminated, as gases generated from the incineration of garbage are rendered odorless at a temperature of about 1,050 degrees F. Thus a leeway of at least 200 degrees F. is afforded. The temperatures are registered continuously on a chart by means of electrical recording pyrometers. An effective, superheated, forced draft system is embodied in the construction of each furnace, the draft being generated by means of direct-connected, motor-driven fans. The air, drawn from the top of the furnace front by the fan, is forced into the regenerator, which is similar in action to that of a vertical boiler. It consists of cast iron tube plates, top and bottom, which support a series of cast iron tubes inside the chamber. A portion of the hot gases from the combustion chamber passes through the tubes and discharges into the connecting flue. The air from the fan circulates around the outside of these tubes, it being baffled in many places. During this process the air is raised in temperature from that of the room to approximately 300 degrees F. The hot blast discharging from the regenerator passes through sheet metal piping, which connects with the air duct under the grates. Suitable valves are provided, and the admission of air under the grates is regulated conveniently from the stoking floor.

Charging Devices Operated by Hydraulic Rams

The charging devices for the cells are mounted on the top of each furnace, and consist of a steel container with bottom dump doors, into which the material is fed. The container doors and furnace charging doors are opened and closed mechanically, this being effected by the use of hydraulic rams, to which the doors are connected. The rams operate under city water pressure, and are controlled from the stoking floor level. Each furnace is equipped with individual dampers, which permit the shutting down of any furnace without influencing the operation of the others. Clean-out doors of ample size are spaced at frequent intervals throughout the different chambers and flues, which allow the various parts to be readily cleaned.

The furnaces and flues are constructed with common brickwork of sufficient thickness, the outside face walls being built of salt glazed brick laid in cement mortor. The non-absorbing nature of these bricks permits the washing-down of the brickwork, and the glazed surface will not readily hold the fine dust, so that the furnaces can always be maintained in a clean and sanitary condition. The furnaces and flues throughout are lined with firebrick of first-class quality, at least 9 ins. in thickness, with a minimum air space of ¾ in. between the firebrick lining and the brick walls. Heavy structural steel buckstays are spaced at suitable intervals, connected with large size tie-rods, for supporting the masonry of the various parts subjected to temperature strains. The radial brick chimney is lined with firebrick for its full height of 175 ft.

Plant Operation

The operation of the plant is very simple and effective. The material is delivered to the plant in the street cleaning department's new type of general-purpose single-horse wagons, and enters the building from the south end, after being weighed on a scale. The wagons are backed against the bumper beam on the tipping floor, and the contents dumped on the charging floor, after which the wagons leave and disperse along the several streets in close proximity to the plant. From the charging floor the material is fed into the containers by the charging men. The containers are operated by the stokers below. The material which is charged into the furnaces drops on a drying hearth at the back of the grates and is then drawn over on the grates, where incineration takes place. The flame and hot gases pass into the combustion chamber, where complete combustion is effected. The heavy dust falls into the bottom of this chamber and is removed through the clean-out doors. At the end of the combustion chamber a firebrick dividing arch is built, which splits the gases leaving the combustion chamber, of which a requisite portion passes on top into the regenerating chamber, while the remainder passes through the bypass flue below the regenerator. from these points the gases enter the up-takes to the connect-flues and thence through the main flue into the chimney.

Removal of Residue

The residue is drawn from the grates through large doors on the furnace fronts and is dropped into dump cars located in the ash-run and operated on a narrow-guage track. Trap-doors in the stoking floor are provided for this purpose, these being closed except when cleaning operations are in progress. The cars are moved to the north end of the ash-run and placed bodily upon an electrically-operated elevator, raised to the bin tipping floor level, when the car is moved over and the residue dumped into the ash bin. This ash bin is equipped with a series of adjustable doors, thus allowing the further removal of residue from the plant in any desired manner.

The Test

During the months of April and May the contractors conducted the required test of 30 days' duration, operating under the normal conditions, during which time the capacity of the plant was judged. On June 28 the official capacity and acceptance test was conducted. Observations were made and readings taken at frequent intervals. Previous to making the test the furnaces were operated for a period of about five hours, for the purpose of raising and maintaining the temperature throughout the furnaces and flues. Observations were made at the time of starting and completing the test, to ascertain the conditions of grates and containers, so as to insure the same cycle of incineration. Requirements referring to density of smoke, analysis of residue and emission of dust from chimney, were found to be satisfactory during the test. The high rate of burning, 116.5 lbs. per sq. ft. of grate area per hour exceeded the guarantee of 50 lbs. by 133 per cent.

Owing to the increased rate of incineration over the estimated amount, the mode of operation has been affected somewhat. The original intention was to operate the plant on a two-unit, day and night shift, basis, which was calculated to dispose of an average of 100 tons of material daily, but it has been found economical to operate the plant on a day shift basis only with the three furnaces burning, especially as the efficiency of the plant has been equally maintained under normal conditions, operated under the supervision of the department. This system has many advantages over the day and night shift basis. First, the life of furnaces will be greater, as temperatures are maintained in a more regular manner and the number of times the furnaces are shut down is reduced to a minimum. Thus strains caused by expansion and contraction are eliminated to the least possible degree; also the most effective and economical method of disposal of garbage by incineration is to reduce the time of storage to a minimum, as otherwise it becomes packed and thereby more expensive to move. Under the present mode of operation an

average of 100 tons of material daily is being disposed of during the day only. Two men are engaged during the night removing the residue from the grates into the ash bin, which permits burning immediately upon starting the next morning. A staff of 1 foreman, 6 stokers, aand 20 laborers constitute the labor requirements for operating the plant. Experiments are now being conducted with a view to reducing the labor at present required, which is not as effective, due to war conditions, as would otherwise be the case.

Bids for Removal of Wastes from Ayer Cantonment Vary Widely

The various army cantonments are essentially cities and interest attaches to the handling of the refuse produced. The cantonment division of the War Department has awarded the contract for the removal of all garbage and waste from the Ayer cantonment to the S. A. Megher Company, soap manufacturers, of Milton, Mass., this firm having been the highest bidder, offering the government $21,600 for the privilege of carting the refuse away.

The ten bids received were exceedingly diverse in their terms. The lowest bidder asked the government to pay him $72,000 for doing the work. Others asked smaller sums, and still others offered the government money for the privilege. The second highest bidder was the Eastern Oil and Rendering Company, with offices at 92 State street, Boston, which bid $7,600 for the privilege of doing the work.

The lowest bidder—that is, the one who asked the government to pay $72,000 for the work—was the Boston Development and Sanitary Company, the firm which now has the contract for removing refuse for the city of Boston. Certain credits which this concern proposed to allow would have amounted to approximately $10,000 per annum, so that the net cost to the government would have been about $62,000, a net loss of about $80,000 as compared with the bid of the successful contractor.

The successful bidder was required to furnish a bond of $25,000 for the faithful performance of the contract, and is required to remove twice daily from the camp about 70 tons of manure, 10 tons of kitchen garbage, to say nothing of a large quantity of tin cans, waste paper, fat, bones, grease, dead animals and other refuse.

Under the terms of the contract he must supply all containers for garbage and other refuse and must make two removals daily for the period of one year, beginning September 1, 1917. The government reserves the right to cancel the contract on thirty days' notice.

Water Purification and Sewage Treatment

Various Methods of Dewatering Activated Sludge

By Edward Bartow, Chief Water Survey Division, University of Illinois, Urbana.

Satisfactory purification of sewage by aeration in the presence of activated sludge has been obtained by us and by many others, but before the method can be considered an unqualified success a practical and economical method of drying the sludge must be found. Various methods have been tried by different investigators, but we have at the risk of duplication experimented with many of these methods at our sewage experiment station, said Dr. Bartow in addressing the American Institute of Chemical Engineers.

Drying on Sand Beds.

Although drying on sandbeds had been tried at Cleveland and we had ourselves tried it, we thought wise to repeat the experiments on better constructed beds than were used in our previous work. The experiments were not successful. Owing to the large amount of moisture in the sludge, 98 to 99 per cent, the solid matter obtainable from a foot depth of sludge would be only from ¼ to½-in., according to the residual moisture content. It was also difficult to separate the sludge and sand. The fertilizer obtained was more or less impure and of decreased value. The sand beds used were one-hundredth of an acre in area and divided into five compartments. Underdrains were overlain with 10 ins. of coarse gravel and 8 ins. of sand. The beds were provided with a canvas cover supported on a frame work so that they could be protected during storms. One compartment was allowed to dry after a single filling, another after two fillings and another after three fillings. In no case were the results sufficiently satisfactory to warrant the use of sandbeds for the drying of the sludge and the production of a commercial fertilizer.

Filter Pressing.

Experiments with a filter press with leaves 8½ in. square operating on a fairly concentrated sludge were also unsatisfactory. It has thus far been impossible for us to obtain a cake of good consistency. Further experiments are to be tried with the hope that better results can be obtained.

Use of Rotary Filter.

Through the courtesy of the Koering Cyaniding Company of Detroit a rotary filter was placed at our disposal. This style of filter is used satisfactorily in filtering slimes in extracting gold and silver by the cyaniding process. The apparatus consists of a cylinder of filtros plates supported on a perforated steel cylinder outside of which, at a distance of about 1 in. is a solid steel outer shell. The material to be filtered is forced into the interior of the cylinder of filtros plates, the cylinder is revolved and a cake of sludge is built up on the inside of the plates. The liquid filters through the plates into the space between the cylinders. Air pressure can be exerted from the interior to dry the cake, and from the exterior to loosen it. The plates can be cleaned by back-flushing with water. The first trial with a comparatively heavy and not very fresh sludge did not give satisfactory results. The quick-opening door could not stand the pressure. Another trial will be given as soon as the door can be replaced.

Using Centrifuges.

Mohlman reported experiments with two small centrifuges, one of the low-speed basket type and the other of the high-speed bottle type. The basket of the low-speed machine was 8 ins. in diameter and 6 ins. deep. The periphery was perforated with numerous holes 1 16 in. in diameter. When the holes were covered with a strip of muslin cloth, approximately 1 gal. of 98 per cent moisture sludge was put into the centrifuge and after 15 minutes, 700 grams of 91 per cent moisture sludge were obtained. The high-speed bottle-type machine reduced the moisture from 98 per cent to 92 per cent in three minutes. Mohlman stated that in order to be economical there should be an automatic arrangement for removing the cake.

The most successful apparatus of this type is the Schafer-ter Meer centrifuge described by Hammond. This machine is said to be very efficient but was too expensive for us to obtain for experimental work.

At Cleveland, Pratt and Gascoigne used a laundry centrifuge with a 26-in. basket, lined with a ¼-in. wire mesh inside of which was a canvas bag. In the best run, when the basket revolved about 1,200 revolutions per minute, 60 gals. of 97½ per cent moisture sludge was added in about 25 minutes, and in 2 hours the moisture content was reduced to 84 per cent. The time required would seem to make this process impracticable.

Working on the assumption that the principle used in drying of china clays or that used in the cream separator might be applicable, a modified basket-type centrifuge and a modified cream separator were tried. The holes of an 8 in. basket centrifuge were covered with a strip of rubber packing. The best results were obtained with 1,500 revolutions per minute, which was the limiting speed of the machine. This would seem to indicate that the process would give efficient results if carried on at an increased speed, but would yield an effluent that must be returned with the sewage to the aeration chamber. A series of tests was made with a cream separator, the bowl of which was modified, by removing the inner disks and discharging the clarified liquid about an inch from the center of the bowl at the top. The sludge added at the top dropped to the bottom of the bowl, and the liquid was thrown over the rim. Sludge cakes containing from 85 to 86 per cent of moisture were obtained by the cream separator in 6 to 8 minutes, which encouraged us to obtain a special machine for further experiments.

A Specially Designed Centrifuge.

A specially designed centrifuge was purchased from the Tolhurst Machine Works of Troy, N. Y. This machine is 12 ins. in diameter, 9½ ins. high and at a speed of 1,800 exerts a centrifugal force of 550 lbs. According to its concentration from 10 to 25 gals. of the sludge are added and 10 lbs. of cake obtained. The sludge cake contains about 88 per cent moisture. The space underneath the rim contains 0.158 cu. ft. Owing to the small size of the machine and to the fact that the material must be scraped out, the time of cleaning is longer than would be required for a larger machine with an opening in the bottom, so that a large machine could undoubtedly have been filled and emptied more rapidly than the small laboratory machine. We have found it entirely possible to fill and empty the small machine four times in one hour. Calculating that the same rate could be used with a 40-in. machine having 46 times the capacity, we could obtain in each filling 460 lbs. of sludge of 88 per cent moisture, equivalent to 55 lbs. of dry material. One 40-in. machine would, therefore, deliver the equivalent of 2,200 lbs. of dry material in a working day of 10 hours. On the supposition that ½ ton of dry material will be obtained from 1,000,000 gals. of sewage, one machine would dewater the sludge from 2,000,000 gals. of sewage per day. The cost of the 40-in. machine at present is only $750 and the power to run it is small enough to make the process appear practical for preparing sludge cake for a dryer.

Cost.

The actual cost of dewatering will depend upon the amount of water that can be removed by the centrifuge, the size of dryer and the amount of coal required for removing the residual water. A drying test using 220 lbs. of 88 per cent sludge cake made by the John P. Devine Company indicates that the dewatering process can be made practical.

Water Works Maintenance and Operation

Official Duty Tests of Steam Turbine Driven Centrifugal Pumps at Sixty-eighth Street Pumping Station, Chicago

Official duty tests of the two 30,000,000-gal. steam turbine-driven centrifugal pumps at the 68th Street pumping station of the Chicago water works were recently made and have just been made public. These pumps with their accessories are the first of their type to be installed in Chicago. Owing to this fact, an effort was made to obtain all possible data on the performance of the various portions of the apparatus and to present this information in a form useful in future designs for similar installations. The results of the tests show that all of the guarantees were met and that the installation is in general conformity with the terms of the contract and specifications. The pumps were installed under a contract by William A. Pope and were tested by three experts: William A. Nelson, for Chicago; R. W. Allerton, for the contractor, and C. J. Bacon, a third expert, chosen by the other two.

Description of Pumping Machinery.

The equipment installed under this contract consists of two duplicate steam turbine-driven centrifugal pumps, complete with all auxiliaries, venturi meters, steam flow meters and other appurtenances. The accompanying half-tone shows the general arrangement.

The rated capacity of each pump is 30,000,000 gals. per day against a head of 140 ft. Each pump has its own suction well from which the water is drawn through an Elliott twin strainer and then through a suction surface condenser before reaching the pumps.

The water leaving the pump passes through a venturi meter which is preceded in the discharge line by a straight pipe of suitable length to insure the proper operation of the meter. The down-stream portion of the meter has a long radius bend and leads directly to a large multiple disc check valve beyond which is a hydraulically operated shut-off valve.

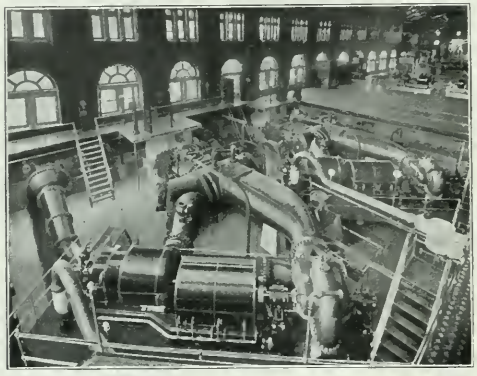
The pump proper is a Worthington horizontal, single impeller, double-suction type without diffusion blades, and is driven through reduction gearing by a steam turbine. The pump, reduction gear and turbine are all mounted on a single sole plate to insure rigidity of alignment.

The turbine is a Kerr "economy type," horizontal, condensing, multistage, nozzle and blade impulse machine with parallel steam flow. It is provided with an oil-relay speed control governor, a constant water pressure governor and also an emergency overspeed governor arranged to trip a steam operated stop valve in the steam supply pipe.

Forced lubrication is provided for the main turbine bearings and for the reduction gear bearings. The return oil is cooled by water circulating pipes in an oil reservoir located in the base of the turbine. There are no steam-driven auxiliaries, both the air and hot well pumps being hydraulically driven.

There is a Worthington hydraulic vacuum pump, using water taken from the main pump discharge line for ejecting the non-condensible vapors from the condenser. As the discharge from the air pump is not contaminated with oil or other objectionable impurities, it is conducted back to the main suction well. Provision is made for obtaining water from other sources in case of starting up or in emergency.

The hot well is drained by a vertical shaft, four-stage, centrifugal pump, direct driven by a pelton wheel. The water required for operation is obtained from the same source as that for the air pump.



VIEW OF TWO STEAM TURBINE DRIVEN CENTRIFUGAL PUMPS AT 68TH ST. STATION, CHICAGO.

The following table gives the principal dimensions and other data relating to the units:

Main Pumping Unit.

Length over all, feet and inches	25-6
Width over all, feet and inches	7-1
Height over all, feet and inches	7-6
Total weight of unit in pounds	64,000
Total weight of sole plate for entire unit, pounds	15,000

Centrifugal Pump.

Make of pump	Henry R. Worthington
Normal speed of pump, r.p.m.	720
Diameter of impeller, in inches	33.5
Diameter of shaft at impeller, in inches	5.5
Diameter and length of each bearing bushing, ins	5x13
Total projected area of pump bearings, square inches	130
Average unit pressure in pounds per square inch on bearings when operating under normal conditions	15.5
Length of pump shaft center to center of bearings in inches	84
Diameter of suction inlet, in inches	36
Diameter of discharge outlet, in inches	30
Net weight of pump without sole plate, in pounds	20,200

Steam Turbine.

Make of turbine	Kerr "Economy"
Brake horse power of turbine	913
Number of stages	14
Number and diameter of rotors	5-21 ins., 5-28 ins., 4-35 ins.
Speed of turbine(normal), rev. per min	3,740
Diameter of steam admission, in inches	5
Diameter of exhaust, in inches	36
Net weight of turbine without sole plate, in pounds	18,000

The reduction gears are of "Economy" type and were made by the Kerr Turbine Company. They are 20-in. involute and have a mechanical efficiency of 98.8 per cent. They consume 11 horse power when operating under normal conditions.

Object of Tests.

The object of the tests was to determine whether or not the machinery complied with the requirements of the specifications and with the contractor's duty guarantee.

The contractor's guarantee as included in his proposal and embodied in the contract is quoted here as follows:

Contractor's Guarantee.

"That: The undersigned that each pumping unit will develop a duty of not less than 129,000,000 ft. lbs. of work per 1,000 lbs. of steam of quality not less than 98 per cent dry when pumping at the rate of 30,000,000 gals. of water per 24 hours against a head of 140 ft. (not including friction head through pump and through suction and discharge piping between suction and discharge pressure gauges, as indicated on city's drawings), and supplied with steam at turbine throttle at a gage pressure of 175 lbs. per sq. in."

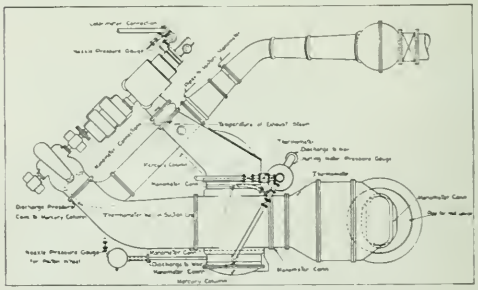
Method of Conducting Tests.

As the two units are duplicates, it was decided to investigate the performances of one pump throughout the entire available range of head and capacity and at different speeds, getting all possible information regarding the power required for auxiliaries and other data. The tests of the other pump were made only over sufficient range to determine its performance at and near the guarantee conditions. The location of the testing apparatus is shown in the accompanying cut.

The more elaborate series of tests was conducted on pump No. 2 as the arrangement permitted more convenience in installing the testing apparatus.

In the case of pump No. 2 twelve runs were made, as follows: One 4-hour run at as near the guarantee point as conditions permitted; two 2-hour runs at slightly above and below the guarantee head, respectively; seven 1-hour runs over as wide a range as possible; and two short runs at maximum and minimum head. These were necessarily of short duration.

Pump No. 1 was tested at three points, one 4-hour run being made at approximately the guarantee point and two 1-hour runs made at points above and below the guarantee points, respectively.



PLAN SHOWING LOCATION OF TESTING APPARATUS.

Owing to somewhat adverse operating conditions, it was impossible to obtain steam of the specified pressure of 175 lbs. at the throttle, the actual pressure averaging around 12 lbs. lower than specified. On this account it was decided to proceed with the tests with the object of approaching as nearly as possible to the guarantee point, by utilizing the maximum steam pressure available, and apply the necessary corrections to the results obtained.

Conclusions.

On official test of pumping unit No. 1, the results obtained at the specified head of 140 ft. were as follows:

	Guaranteed	Obtained
Capacity—1,000,000 gals. per 24 hours	30.0	30.8
Duty—1,000,000 ft. lbs. per 1,000 lbs. steam	129.0	132.0

On official test of pumping unit No. 2, the results obtained at the specified head of 140 ft. were as follows:

	Guaranteed	Obtained
Capacity—1,000,000 gals. per 24 hours.....	30.0	33.85
Duty—1,000,000 ft. lbs. per 1,000 lbs. steam..	129.0	135.50

The installation fully complied with all the requirements of the contract and specifications under the scope of the board of experts authorized to conduct the official tests.

Does Installation of Water Meters Affect Public Health?

The oldest objection to metering a public water supply rests on misinformation. Wherever meterage is proposed its advocates must contend with the fallacious belief that the introduction of meters so curtails the legitimate use of water that the public health is impaired. Commenting on this topic, M. Z. Bair, principal assistant engineer, Ohio state department of health, says:

It is my opinion that the metering of water has only an indirect effect upon public health. It does not seem possible that the limited use of water which might result from the installation of meters would in any way affect the health of the consumers. The most interesting example of the effect of metering that has come to my attention was the case of Cambridge, Ohio, which recently placed in operation a modern purification plant, replacing a grossly polluted and most unattractive supply. The water purification plant was designed for 2,250,000 gals., and following its installation the water consumption at times reached 3,000,000 gals., making it necessary to resort to the use of an unsafe emergency supply. If meters had been installed it is quite likely that the capacity of the water purification plant would not have been exceeded and the consumers would not have been endangered by the use of an unsafe emergency supply. I understand that this condition is being corrected by the rapid installation of meters.

In conclusion, I wish to say that the division of sanitary engineering of this department has always recommended the installation of meters, as we feel that is is the only fair and efficient way in which to sell water.

Springfield, Mass., Avoids Frozen Water Meters

By the use of properly designed meter boxes the city of Springfield, Mass., has entirely done away with those losses and inconveniences that result from frozen water meters. The Springfield Water Department uses a double cover box, installing 20-inch covers for all sizes of meters up to 1 inch. This gives ample air space between the risers and walls of the box. During the winter when the official tests were taken, the frost penetrated to the depth of 6 feet, but there was not a single frozen meter among the ones installed in the "Wabash" double-covered boxes. At the same time there were several hundred frozen meters among those set in basements.

Bridges and Buildings

New Bridge Designs of the Minnesota Highway Commission

Two new designs for highway bridges are reported by Carl E. Nagel, deputy state engineer of Minnesota, in charge of bridge work. These designs are a new cellular slab bridge and a concrete pile trestle bridge.

New Cellular Slab Bridge

On account of the increase in the price of steel, the I-beam span bridge with a concrete floor has advanced considerably in cost, and where the commission have furnished plans for his type and also for the flat slab reinforced concrete bridge, to be bid on at the same time, they found that in most cases the bids on the concrete bridge were nearly as low or lower than on the steel type.

In this solid slab type the great weight of the concrete contained is serious for several reasons. In the case of the 23-ft. span, 70 per cent of the strength of the bridge is required to carry the weight of the superstructure and 30 per cent to carry the traction engine. Another disadvantage is the difficulty of supporting the concrete when poured in the forms. In many cases not enough support has been supplied and the temporary false work has settled under the load of the concrete, resulting in actual damage to the strength of the bridge, as well as giving an unsightly appearance to the structure.

As about 50 per cent of the bridges for which the commission have furnished plans are 30 ft. or less in length or combinations of such short spans, they have given special study to such spans and have designed a new type of construction, which is still more economical than the flat slab superstructure, as well as being lighter and thereby avoiding some of the difficulties encountered with the solid slab.

The new type is cored out on the under side by semi-circular arches of corrugated metal which form longitudinal reinforced concrete tee-beams, with cross beams, as shown in the accompanying cut, which is a plan for a half size model of a 23-ft. span, 18-ft. roadway bridge. This type uses one-third less concrete than the flat slab design and the forms are cheaper, as the corrugated metal arches are removed after the concrete has set and can be used repeatedly.

Concrete Pile Trestle Bridges

The most common cause for replacing old bridges has been on account of the old abutments and piers being in very bad condition. It is also true that most of the superstructures were too light to be worth reusing but they might have served for several more years for ordinary wagon loads.

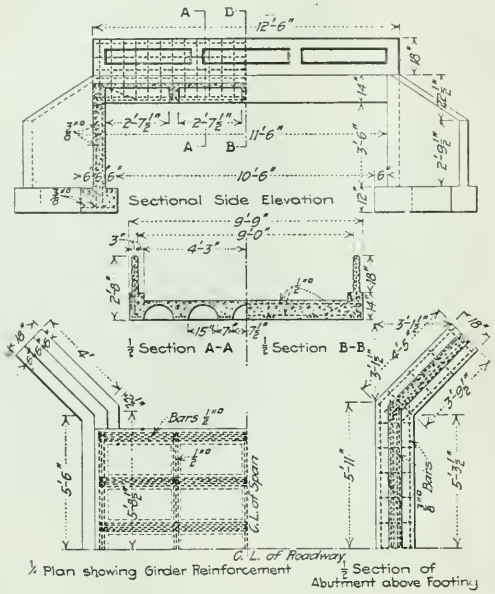
Owing to the limited funds available when these bridges were built, they were made considerably less expensive in first cost by not carrying the footings down well below the bed of the stream. Later the channel changed its course, so that the deepest part came over against one of the abutments or sometimes the whole bed of the stream was gradually cut out and lowered so that the abutments were undermined.

In the state plans for bridges the abutments and piers are carried down below probable undermining at a consequent increase in cost for abutment work.

In the commission's search for a type of substructure that would be less expensive and at the same time provide safety against undermining they found that the railroad companies have adopted the concrete pile trestle bridge to quite an extent and they have studied this type with the idea of using it in highway bridges.

In this form of construction reinforced concrete piles are cast in forms on the ground and after the concrete has set for

about 30 days the piles are set up on end and driven with a large pile driver. The top of the pile projects above the ground and a concrete cap is cast, surrounding the top of the piles in each bent and forming a support for the superstructure.



NEW CELLULAR SLAB BRIDGE USED BY MINNESOTA HIGHWAY COMMISSION.

The most economical span between the bents for ordinary conditions in highway work is about 20 ft. and the new cellular slab superstructure described in this article is a very economical design to use for this substructure. No end abutments are used and the bridge consists of enough short spans to provide the proper water way after allowing the fill to run through the end piles on a 1 to 1 slope with riprap protection.

The bridge is very similar to the wood pile trestle bridges which have given such good service, except that concrete is used throughout, so that the rotting of the piles and joists and the wearing out of the plank floor is eliminated. In locations where it is not feasible to block up the channel with intermediate pile bents, the construction could consist of a long center span carried on a double row of concrete piles with a large concrete cap and with the approaches consisting of concrete pile trestles. Among the advantages of this type of substructure work, one of the most important is the fact that no excavation is necessary for foundations, thereby greatly reducing the cost of construction.

The available working season will practically be doubled in length of time as even a slight raise in water level prevents cofferdam excavation, while the piles can be driven at all stages of water level, except flood stages, which are generally of short duration. This will allow contractors to employ laborers at a time of the year when harvesting is not in progress and fewer laborers will be necessary as more equipment will be used instead.

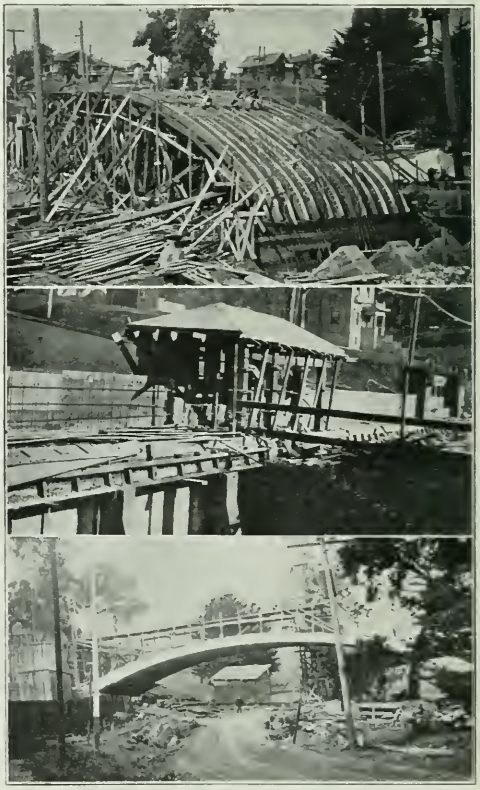
Bridges of this type can conveniently be increased in length, should more water have to be carried because of extensive new drainage work upstream from such a bridge, as there are no end abutments to be replaced by piers.

There have been many cases where old bridges have had to be rebuilt because the abutments have been undermined by a drainage ditch run under the bridge in which case the bed of the stream was artificially lowered but with the concrete pile bridge this would not cause any trouble.

These bridges are most economical where a large number are let under one contract because the cost of shipping the heavy equipment to the territory is distributed and each bridge is charged with only a fractional part of this expense, and this type is especially adapted to the construction of bridges under a bond issue and one county contemplated building 102 bridges this season and thereby eliminating the expensive maintenance costs on the old bridges, while they are paying for the new ones.

Design and Constructional Features of the Oakland Avenue Reinforced Concrete Bridge, Piedmont, Cal.

The design and constructional features of the new reinforced bridge on Oakland avenue, Piedmont, Cal., are here illustrated and described, with special reference to unusual details. One novel feature is the introduction of four covered resting places supported by light concrete columns and covered with Spanish tile.



CONSTRUCTION VIEWS OF OAKLAND AVE. REINFORCED CONCRETE BRIDGE, PIEDMONT, CALIF.

At the portals are four large pylons, capped with decorations cast in concrete and inclosing large ornamental electric lights. The total length of the structure is 362 ft. 10 in., including a central arch span of 130 ft., with symmetrical ap-

proaches composed of reinforced slabs supported by girders and columns inclosed in 6-in. exterior curtain walls. Each transvere bent is made up of three columns.

The roadway is 22 ft. wide, with an additional 6-ft. sidewalk on either side. The intrados curve of the arch was chosen for beauty as well as economy. The rib was analyzed by the elastic theory, and both temperature and rib shortening were provided for. The slab of the approaches and the arch were designed to carry an interurban electric car, and the sidewalks were designed for a live load of 150 lbs. per sq. ft., carried by ornamental brackets rigidly connected to the arch rib and approach slabs.

There was a timber trestle on the site containing about 40,000 ft. of lumber, and this was largely used for shoring and centering for the new bridge. The excavation in both abutment pits was made with teams, slips and plows. The soil was firm clay and occasional gravel, with but little moisture.

The stone used was a blue trap from a quarry near the site, and the concrete in the bases of the piers was laid for 60 cts. per cu. yd., $4 per day being paid to concrete men. It may be mentioned that the false work of the arch was made of 8x10-in., 8x12-in. and 10x12-in. stock. The bents were on approximately 5-ft. centers, and the posts of each bent on 6-ft. centers. The posts were placed normal to the intrados curve, and were supported on continuous sills firmly imbedded in the soil. The false work was unusually heavy and clumsy, but the timber from the trestle was old and its strength could only be guessed at. Heavy caps were placed transversely on each bent, the caps in turn supporting longitudinal stringers on 2-ft. centers.

There were placed on top of the stringers 2x4-in. pieces, blocked up and sprung to the curve. In some portions of the intrados curve where the curvature is great, 2x4-in. stock could not be sprung without splitting, and use was made of two pieces of 1x6-in., nailed together. It is said that these readily took the desired spring, and the variation from the true curve was practically nil when the decking was finally placed. Constant wetting down (sometimes four times daily) kept the decking in excellent condition. Points on the intrados curve, near the crown, were built ¼ in. higher than required to allow for settlement in the foundation of the false work.

The bridge was designed by John B. Leonard, of San Francisco, and the writer is indebted to Engineer W. P. Day, of San Francisco, for the photographs and data on this bridge. He states that the concrete of the rib was poured thru timber chutes leading from a hoist at the center. Doors in the chute were provided in case the concrete flowed too rapidly, and separated the coarser from the finer components, but their use was found unnecessary, the pitch of the chute being a minimum.

It is said that on the completion of the casting, and for several days thereafter, the arch was wet down four times daily. The usual buckling of the forms at the crown, after pouring the haunches, did not occur, owing to the inclination of the posts. The false work remained under the rib for about six weeks. The contractor deemed it proper to strike centers before the spandrel wall forms were set in place, so as to allow the arch to take its unconstrained shape, without subjecting the walls to the consequent stress.

The approaches are symmetrical, each being a 15-in. reinforced slab supported on transverse girders. The forms were made in the regulation way, and no difficulties were encountered. The entire lower approach was poured thru the chute, the length of the latter from the hoist over the mixer being 180 ft. The chute was 18 in. wide and 10 in. deep, and had a drop of 2½ in. per ft.

The mix being run a little wet, produced a perfect concrete at the extreme end. On account of the depth of the girders they were poured in two parts, 4x12-in. blocks, and ⅜-in. roads were used to provide for horizontal shear at the plane where the work was stopped. All of the side walls were poured to the bottom of the sidewalk, a dap of 1 in. being left for each bracket and anchor rods provided for each. The upper approach could not be poured by the chute without building a very high tower, on account of the grade of the bridge, and resort was made to the regulation buggies, hoisting first from the mixer to a runway over the arch.

Four expansion joints were used in the structure, each arranged so as to be hidden by the piers. The use of asphalt was originally contemplated, but was replaced by two thicknesses of heavy felt. Little or no dirt can penetrate the joint, and it is believed that a better working joint has been obtained than would have been produced by the asphalted joint, the material of which would expand and contract with variations in temperature. This bridge cost about $36,000, with electric lighting effects, and about 2,250 cu. yds. of concrete and 80 tons of steel were placed in it.

Sales Engineering

Selling the Services of a Construction Company

By Leonard C. Wasson, President Aberthaw Construction Co., Boston, and W. P. Anderson, President, The Ferro Concrete Construction Co., Cincinnati.

The question is asked, What has a construction company to sell? According to the type of contract this may be a building, or it may be the services requisite to construction of a building, said Mr. Wasson in addressing the World's Salesmanship Congress. In order to grasp the selling problem it is necessary briefly to review present methods of letting contracts. The most common is the lump sum contract. This is used exclusively on public work by the federal and state governments, municipalities, and largely in private work. Bids for public work are publicly advertised for, and on private work it is often by invitation to a selected list. When this method of letting work is used there is no selling necessary or possible. The work is awarded to the lowest bidder unless it is clearly shown that he is unfit to be entrusted with the work, when the next man may do enough selling to prove he is fit, and that he is worth the difference in price between his bid and that of the lowest.

Going After Cost Plus Contracts.

What the contractor really does under the above method is to agree to build at his own expense a structure according to the plans and specifications provided by the buyer and to sell it for a lump sum arranged for in advance, when completed to the liking of the buyer and his engineer. The price does not necessarily indicate the real cost of construction plus a fair remuneration for the contractor's services. The purchaser agrees to buy on the installment plan by making partial pay-

ments. Contracts on some privately-owned work are let on cost plus fixed sum or percentage profit basis, and for these aggressive selling is needed. Some of the arguments which the salesman can use to persuade a buyer to accept these types of contracts are: The work can be started before the plans are made and six weeks' time can be saved. The contractor's and the owner's interests are mutual, therefore, better and cheaper results are obtained than with a lump sum contract where the parties' interests are antagonistic. Changes, either additions or deductions, can be easily made and at cost. The mutuality affects the design, purchasing of material, and sub-contracts, obtaining of labor and finance. Eliminates friction with the inspector.

Specific Suggestions.

The first step necessary is to seek out opportunities for obtaining these types of contracts. The most effective method is by visiting cities and towns seeking information from all available sources, including calling on the various parties who are thought to be considering the erection of new buildings. This method is slow and expensive. One man cannot cover much territory and do it well.

A less expensive way to cover a large field is by advertising literature. Volumes have already been written and more will be written on this important subject. It is a big problem. The construction company who is seeking day work or fixed sum profit contracts needs to reach directly the executive official in whose hands rest the final decision as to the awarding of a contract.

The writer's company has, after various experiments, decided on the plan of sending something once a month to its mailing list. This necessitates something bright, interesting, and brief, and, therefore, not very expensive in itself. If the advertising makes enough impression on the recipient to draw an inquiry, it has done its work. These are very desirable as they bring the salesman and buyer together on a very pleasant basis much increasing the former's effectiveness. Then the real selling campaign begins.

Methods of Approach.

No fixed rule can be laid down of methods to be followed. Assume he is a total stranger at the start. Write a letter for an appointment; send some information and perhaps literature to make him want one. Then get a letter of introduction from a mutual friend. This will get you past the office boy. The representative who calls must be very pleasing in personality, with ability to meet the prospect on his own footing, and to make a good impression. He should be able to answer almost any question asked him regarding the operating details of his own company intelligently and authoritatively. He must be perfectly frank and truthful, even if it results in losing an order. A favorable impression is left that some time will help the salesman's company. Many salesmen fall down by their failure to tell the truth when it hurts.

He must everlastingly present the main issues; the decision must be hammered through on principles.

It is desirable that he should know enough about other lines of work, so that he can, without being officious, offer advice wisely on matters concerning the business of the prospective client.

After making a man's acquaintance the steps which follow are easier to determine upon. They consist in part of getting his friends to write or see him in your behalf. He is affected most by successful competitors in his own line of business who write or see him and endorse your company. Induce him to write to ten or more of your own recent clients so as to get disinterested opinion from those who have had recent experience with you as to your worthiness. If they come from men respected in the business world they will frequently land the job.

Backing Up the Selling Force.

This leads again to the question, What has a construction company got to sell under the cost plus a fixed sum type of contract? Its service, that is, its ability to construct a given piece of work quickly, economically and safely to the complete satisfaction of the owner and his engineer, so that he will be satisfied or more than satisfied with the final result, and can be relied upon as a salesman to help you sell subsequent work on account of his enthusiastic endorsement of the service he has received. It is certain that a company doing this type of business must give better service than the ordinary run of contractors in order to make it worth the owner's while to employ the company to do its work rather than another contractor as the result of competitive bids. The construction company must, therefore, have a most efficient organization to back up its selling force. This includes an efficient engineering department, as frequently the designs of the structure have to be made, or if these are completed, there are designs of mechanical plant, general principles of the execution of the work, details of forms for reinforced concrete, details of windows, doors and miscellaneous iron work and minor parts of various sorts, also schedules of materials to be bought. The execution must be planned by competent superintendents; there must be a standing organization which can be put upon work promptly, which has been tried and found trustworthy, besides a good employment department for obtaining labor. Also estimating, purchasing, bookkeeping, auditing and cost accounting departments; and in these days of congested transportation, a traffic department.

It has been found desirable and almost necessary for the salesman to keep in touch with the owner and the contract from start to finish, in order to see that every detail of the agreement with the owner, both written and verbal, is lived up to; not only in letter but in the spirit, and, if possible, that results may be even better than those promised when the job was sold.

The salesman must be somewhat of a free lance, particularly in regard to his time, so that he can keep an appointment at the purchaser's convenience without fail. It requires a much different temperament, for a man whose time is largely devoted to selling and not fully occupied, from the man who executes the work, and must be always available to supervise details of construction, and who is largely absorbed in numerous details which do not give him time for reflection and decision on the larger problems which come before the salesman. Therefore, the two activities cannot be combined in one man.

Experience of the Ferro Concrete Construction Co.

The experience of the Ferro Concrete Construction Company of Cincinnati in selling its services were described by W. P. Anderson, president, as follows:

"From the experience of our company I feel that salesmanship plays an important part in obtaining work on a competitive basis. This scarcely applies to competitive work let by public bodies, but even they have some discressionary power, and it is advisable to have those who control the letting of such work familiar with the reputation of the bidder. In bidding on private competitive work, the owner is not bound by any rules and often favors a contractor on account of his reputation for fair dealing and excellent work.

Expense of Bidding.

"There are certain general points to be considered in the selling problem, regardless of the form of contract and other points must be considered with particular reference to the class of contract under which the salesman is endeavoring to get the work. The overhead expense of a construction company is a small percentage of its total business. It can be made lower on work done on a cost-plus-a-fixed-sum or percentage than for work done on a flat price, as in the latter case many more

careful and expensive estimates of cost are required in getting work. The money saved can be utilized in giving more to actual clients, by being liberal in settling disputed points, thus causing them to become repeaters and boosters, which is one of the greatest selling assets. The tendency, in competitive bidding, to estimate a great number of jobs is partially due to the fact that engineers and architects expect it. Sometimes the contractor guesses or obtains a figure from other contractors in order to put in a high bid to satisfy the architect. High bidding does not hurt the competitive bidder as it creates a feeling of superiority, and other things being equal, the superior firm gets the job, often at a higher price than his competitor. This may have a different effect on clients letting work on a cost plus a fixed sum or percentage basis, as here he is vitally interested in the contractor's ability to do good work at a minimum cost and maximum speed, with as little annoyance and friction as possible. Our salesmen emphasize these points as well as our firm's engineering ability, which often causes a great saving in original cost or in the operating cost when the structure is in use, and we bring these facts home by having former clients write or speak of them to prospective clients.

Salesmen Should Be Independent.

"There is a tendency for architects and owners rather to look down upon the contractor, hardly considering him their equal but as a slick fellow who will bear close watching. They consider it a favor on their part to allow the contractor to bid, not realizing the expense he is put to in so doing, and that they are the ones that need the favor and that, in reality, the shoe is on the other foot. The salesman should be independent and not tolerate this attitude, but consider himself absolutely on an equal plane. The class of men in control of the firms who are forging ahead in the field of getting work on a cost-plus-a-fixed-sum or percentage basis are of the highest type and the reputation for honesty and merit required for this class of work does not go with servility.

"Over 90 per cent of our present work was obtained on a cost-plus-a-fixed-sum or percentage basis, which is growing in popularity, due to the many advantages inherent in this form of contract. The Munitions Board, Council of National Defense, are thus letting contracts due to the speed obtained thereby. The salesman must overcome a prejudice against this form of contract as, at first, an owner cannot see the merits, often because he does not get work this way, not realizing the difficulty of checking costs in a factory, with large overhead expense and more than one client, is overcome where practically the entire work is done at one spot and for the client exclusively. The feeling that the contractor is a robber and holdup by going after work he is unfitted for, which was in evidence in General Goethals' position in the disagreement between him and Messrs. Eustis and Clark, must be overcome, but this feeling, in general, may be made an asset to the salesman where he can show that his firm does not possess these qualities and can convince the owner of the manifold advantages of the cost-plus-a-fixed-sum or percentage contract.

Salesmen You Ought to Know

He is known as The Road Machine Man and signs the hotel register as P. C. Elsey of Quincy, Ill. Take a look at the halftone and you will henceforth be able to pick P. C. up at the road shows and elsewhere. He is with the Baker Manufacturing Company of Springfield, Ill., and he travels the grand old State of Missouri, where, despite Reed and Stone, they have to be shown. He is doing missionary work among the contractors and county clerks on the famous Maney Four-Wheeled Scrapers and "Uncle Jim" Levelers, both of which are practically new in Missouri. Of course he also sells the rest of the line handled by his firm. He is now independent, as his kids have all grown up and are doing for themselves. He takes such long jumps that nothing shorter than the Missouri Pacific reaches all the places he makes. He frequently buys motor cars from the livery people who never forget that he has to go

P. C. ELSEY.

and they charge accordingly. The cars are retained by these livery sharps, however, so they can sell him again when he comes to town. He says the descendants of the James and Younger brothers are all in the livery business in Missouri. When he gets a bit of spare time he visits the Ozark country by way of relaxation. He gets his fun as he goes along—he says it is a picnic to sell Maneys.

This busy individual is not an editor, although his desk looks likes ours about three days removed from the dead line. This is Mr. Carleton Hill Jones of 1015 Newhouse Building,

CARLETON H. JONES.

Salt Lake City, Utah. He represents the Chain Belt Company of Milwaukee and the Diamond Rubber Company of Akron, Ohio. He covers Utah, Nevada, Idaho and Wyoming. Although a resident of Utah, he is not a Mormon—in fact he is not married at all. Like the machine that he sells, he is a batch mixer. His freedom from domestic worries is not entirely responsible for the gladsome, carefree expression he is wearing in the picture. The camera caught him in the act of signing an order to the Chain Belt Company for the second 14-S Concrete Mixer (Rex) just sold to the Lynch-Cannon Engineering Company of Salt Lake. Some people have all the luck.

From Workers in Field and Office

The Concrete Road Roller Successfully Employed on Vermilion County (Illinois) Roads

The Editor of Municipal Engineering:

Sir—

Concrete roads are here and are likely to stay for a long time, and it behooves engineers to eliminate all preventable defects and to improve the character of the work, both the surface finish and the general character.

Engaged in building 144 miles of these roads, and having already completed 80 miles of them, and having them under

ROLLER USED ON CONCRETE ROADS, VERMILION COUNTY, ILLINOIS.

constant supervision during construction, I may be in a better position than most engineers to detect defects, and, having diagnosed the disease, to suggest a remedy.

Why Roller Is Used

The elimination of the excessive water which is necessary to use in mixing and placing concrete roads, and the compacting of the surface, have claimed the attention of all engaged in this class of construction, especially engineers. Henry W. Bowlby, former state engineer, State of Oregon, invented, patented and successfully used a roller of the contour of the road, operated by a gas engine running on the side forms. Capt. J. J. Gaillard, city engineer, Macon, Ga., uses a small hand roller of dimensions unknown to the writer. (Described in Plant Units and Layouts Section of this issue.—Editor.) City Engineer Johnston, of Sioux City, uses dry sand cement mortar worked in by hand floats, all of these for the purpose of removing excess water from the concrete and compacting the surface, and I had attempted it by persistent working with templates, floats, belts, etc.

Repeated laboratory tests made by the writer and others have proved beyond question that excess water weakens concrete, particularly in the early periods, in both tensile and compressive strength, in proportion to the excess of water used. There can be little doubt that excessive water leaves concrete porous and tends to produce excessive shrinkage in warm or windy weather. The matter was the frequent subject of discussion between Mr. F. Kaufman, of the Portland Cement Association, and the writer. Both sought a remedy, if possible an inexpensive one, that could be tried out on our county bond roads, contracts for which had been let and for which there were no further funds available. He agreed to furnish a roller if I would agree to find a job on which to experiment with it. The first roller, 9 in. in diameter, 4 ft. long, made of No. 18 galvanized iron, with heads of the same material, and weighing 46 lbs., was placed on Division 5 of our county bond roads. The contractor, Prendergast-Clark Construction Company, agreed to give it a trial. So impressed was Mr. Prendergast by the work done by this roller that he wouldn't be without one. This roller has been in use some two months and has surpassed our expectations, leading to our determination to further experiment with sizes and weights till an ideal roller is produced.

Four additional rollers have since been placed. The Granite City Lime and Cement Company have placed one on each of their Divisions 2 and 7, 12 in. in diameter, 4 ft. long, with wood heads, weighing 56 pounds. P. M. Johnston & Co., Division No. 8, one 10 in. in diameter, 5 ft. long, weighing 54 pounds, and John F. McMahon, Division No. 6, 12 in. in diameter, 5 ft. long, and weighing 66 pounds, the last four using No. 20 galvanized iron. It is difficult to determine which of these is the best. All show splendid results, but the roller 12 in. in diameter, 4 ft. long, seems to be most convenient. The larger sizes are clumsy and unwieldy. One man can readily handle the smaller size.

The immediate effect of the use of these rollers is a marked lessening of the water content, a forcing down of the coarse aggregate (particularly as applied to crushed stone), leaving a smooth, dense surface which is easy to finish. These rollers are popular with engineers, contractors and workmen. All seem to take a particular interest in seeing them work successfully, and they have prevented almost entirely hair checking and wind cracks in hot and windy weather. This latter effect alone would justify their use, as all familiar with this class of work can attest. The most valuable effect, however, is that it lessens the cost of finishing and makes a better finish than either the hand float or belt.

Use of Roller

The method used here is as follows: Immediately after the template is see-sawed across the forms, the roller, fitted with a 10-ft. handle (it may be longer for wider roads), is pushed slowly across the concrete and then is pulled back again over the same area. The roller is lifted forward the length of itself; the rolling is continued until the template is reached. A stream of water free of cement and aggregate flows in a wide stream ahead of it and over the side forms as the roller moves in each direction. After the roller is used the first time a long handle float is drawn across the pavement, smoothing the surface. Water rapidly collects on this surface. The use of the roller a second time disposes of this water by pushing it over the side as the roller moves back and forth. If a great excess of water happens to be used, rolling must be continued till the excess disappears. Concrete roads caught in the rain may be refinished readily by using the roller. After the second rolling the concrete is ready for final finish with long-handle float.

An accurate record of the stations on the various divisions where the rollers are in use is on file for future observation of the roads under traffic. A close-up view of the roller is here shown.

Very truly yours,

Danville, Ill. P. C. McArdle,
Superintending Engineer, Vermilion County.

Home-Made Street Roller Tender or Tool Wagon

The Editor of Municipal Engineering:

Sir—

The steam roller tender or tool wagon here illustrated is made from the running gear and other parts of old garbage wagons, ash wagons, dump carts, buggies, etc., which have been junked. This is done at the shop, which is maintained by this department. As we utilize old material such as we have we do not have regular plans or specifications. These

A HOME-MADE STEAM ROLLER TENDER OR TOOL WAGON.

tenders have several compartments, in which are stored the various supplies required by the roller, such as coal, grease, and other tools used on the job, such as shovels, picks, etc.

Very truly yours,

F. H. Clark,

Springfield, Mass. Supt. Streets and Engineering.

What Type of Engineers Should Go Into the Contracting Business?

The Editor of Municipal Engineering:

Sir—

I do not think that any engineer should attempt contracting unless he has a liking for construction work, a passion for organization, equipment and men, and is more or less of a good loser. To elaborate this somewhat, all undertakings in which engineers and contractors are engaged consist of two parts, the design and the construction. While the two are merged more or less into each other, one may be a very competent designer and be a very poor constructor, and vice versa. In other words, a man may have a dream of how a thing should look when completed, yet may have only a vague idea of how the mechanical details for the carrying out of his dream should be arranged to carry his idea out economically. And here is where your passion for organization steps in. A good organizer never is satisfied until each detail is planned and carried out in the simplest, easiest and most efficient, consequently the most economical, manner. And there is probably the most important point in contracting to-day.

If, then, your candidate for contracting can go to letting after letting, spending his money, without getting anything, without getting stampeded, and bidding in a job where he is certain to lose; and if, after he gets it, he can sit down calmly and see the profits he supposed he had in his contract gradually disappear through causes over which he has no control and which he can't even fight, then let him tackle the game. If not, he had better stay out of it.

All of the above refers, of course, to the man that has to start in a small way, as most engineers would, I presume. If a man has means to engage in contracting on a large scale, I do not think he ought to risk his own money until after several years of experience with a good contracting firm doing the same class of construction work in which he himself expects to engage later.

Very truly yours,

Marion, Iowa. A. P. Munsen, Contractor.

(The foregoing letter from a trained and experienced engineer who has made good in the contracting game was contributed on special invitation. He "hopes he has made it plain that contracting is not all scittles and beer, but a mighty tough game at times."—Editor.)

Why Cities Should Continue Making Public Improvements Without Waiting to See How the War Turns Out

The Editor of Municipal Engineering:

Sir—Humanity and civilization represented by the allied nations of the world will triumph over brutal barbarism as represented by Prussia, the Hohenzollerns and the Hapsburgs. Were this not so we might as well spend the money on public improvements as to leave it for confiscation by the Kaiser. A Prussian conquest is, I believe, now beyond attainment and we need only be concerned how best to support our country in this hour of great need and to carry on business as usual.

To carry on business as usual demands that construction work, in so far as is feasible, be continued.

If the need for a public improvement now exists then such need will continue to exist and the only factors we should consider are necessity and cost. It is to be taken for granted that when a public improvement is planned that it is a necessary improvement. There remains then but the question of cost to be considered and whether the cost will be greater if done now or later.

It is illogical to assume that lower costs will prevail on any great number of items of materials or labor, because both materials and men are being consumed in this world war and by consumed I mean that very little salvage of materials will occur and what is sad to believe is that many of our best men will be wiped out of existence also.

The remaining members of the human family will have to be cared for and an immense amount of rebuilding of all classes must necessarily follow the declaration of peace. A decrease in cost of steel and other metals may not be expected within two years after hostilities are suspended and other building materials to a great extent will also hold firm.

Construction work is one means of keeping money in circulation. Stop all labor and allied pay rolls and chaos would result. No community should rashly stop making necessary improvements if money is obtainable for financing the contracts.

A good part of the money required to finance our war expenditures will come from the wage earners if they are employed, but the same potential buyer of a liberty or similar bond will become a public charge if he cannot find employment.

The labor problem may tend to cause a cessation of work, but this is a question which will tend to solve itself despite the activities of Pro-German labor agitators. The activity of such agitators should be curbed and it may be found advisable to form state or federal commissions to inquire into and adjust on an equitable basis all complaints, reworking conditions, rates of pay, etc. It is very probable that this is a matter which could be handled by the federal government to the end that no strike would be allowed which would interfere with the prosecution of the war. The production of food, clothing, munitions, etc., and the handling, storage and transportation of same should come within the jurisdiction of such commissions

as regards the settlement of workmen's complaints and the prevention of strikes by employes engaged in such work. It may be asked what this has to do with the prosecution of public works, but if it is realized that federal commissions or some similar bodies can control in a fair manner all labor questions of a national import then there is no reason why every state in the Union should not have its own labor commission to handle all matters of local importance. Such commissions may exist in some states and if so they should have broad powers so that they can prevent either party to a labor dispute taking an undue or unfair advantage of the other. The honest and efficient administration of such commissions will tend to cause the employer and employe to arrive at a better understanding than now exists.

The above is but a general summary of some of the factors affecting public improvement works and it is to be hoped that all responsible persons will consider the probability that lower costs will not prevail for some years after the war and that in the meantime the necessary improvements will be adding to the health, comfort and safety of the people who, in the end, will have to pay the bills.

Yours very truly,

W. R. Harris.

Builders Exchange, Louiville, Ky.,
September 1, 1917.

Who Is to Blame?

The Editor of Municipal Engineering, Sir: Rarely does a road discussion take place that some one does not deliver a broad-side concerning the high-pitched earth road—the dirt road with side slopes so steep that a flivver travels cornerwise like a pug dog trotting, or, if the road is wet, everybody crawls along the crest like a small boy on the barn roof. And, almost invariably this broad-side is aimed at the road officials. But, are the officials alone to blame? Doubtless they are directly responsible but is it not barely possible that some of the rest of us should be handed some of the blame?

Tucked away some place in nearly all road books, bulletins, and speeches is a statement to the effect that "an earth road

A SECTION OF THE DIXIE HIGHWAY IN ILLINOIS. MISTREATED PERIODICALLY WITH A TRACTOR AND LEVELER. CROWN 2 1-5 IN. TO THE FOOT. UNCOMFORTABLE WHEN DRY—DANGEROUS WHEN WET.

should have a maximum crown of about one inch to the foot." And so it should, but what comes next? Why, these same books, bulletins, and speeches, aided and abetted by catalogs, salesmen, and machinery demonstrators unite with one mighty voice to say that the way to care for an earth road is to "begin at the sides and work towards the center carrying the dirt inward to build up the crown."

Good! Anybody can understand that. Anybody can get aboard a road machine and see that its nose is in the ground and that a goodly quantity of dirt is moving to the middle to build up the crown. Who remembers anything about that "inch to the foot" business? And if a wee small voice should call it to mind who cares for a little noise like that? The big racket is to "begin at the edge and work to the center to build up the crown." And anyway the chief function of an earth road is to furnish a place to run a big tractor and grader—the bigger the better—the safety and comfort of traffic is merely incidental.

The trouble is that a method has been emphasized to the detriment of the desired result. Whenever the public, the engineer, the road official, and the machinery man, get clearly into their heads that the shape of the road is the important item, whenever they learn to recognize a properly shaped road on sight and to know that it is immaterial whether the dirt moves inward, outward, or any other way, as long as the proper shape is being secured, then these disgraces to civilization will disappear and be replaced with well-kept, slightly crowned road-ways—comfortable and safe to travel and easy to maintain.

Very truly yours,

C. C. WILEY,
Instructor in Highway Engineering,
University of Illinois.

Urbana, September 13, 1917.

Mobile Equipment Drives Trench Sheeting Swiftly and Economically

The Editor of Municipal Engineering:

Sir—

Sewer construction on the New Jersey coast is always attended with great difficulty. Soil in many locations is pure white sand, often completely saturated to within 1 or 2 ft. of the surface with ground water. Under these conditions all

CONTRACTOR'S IMPROVED EQUIPMENT FOR DRIVING SHEET PILING.

excavation must be completely inclosed in very tight sheeting, not so much for the purpose of keeping the ground water out as to prevent the sand from shooting into the trench thru any openings which may exist. For the same reason it is most essential to drive the sheeting to within 1 to 2 ft. below the subgrade, depending upon the depth of the trench.

In excavating the trenches for a sewer system constructed under the above conditions it was found to be too slow and expensive to drive the sheeting by hand. As a result a special

rig was devised by the contractor from the equipment which he had on hand. This outfit is illustrated by the accompanying half-tone, and consisted of a light steam hammer swung from a derrick, mounted on a motor truck. Steam for operating the hammer was furnished by a small road roller, thus making the whole outfit easily mobile. In driving the sheeting a water jet was used to aid in rapid penetration.

With seven men an average day's work consisted in driving from 200 to 220 2-in.x8-in.x12-ft. sheet piling in a trench 10 ft. deep. The cost, including equipment charges, labor and water for jetting, was approximately 27 cts. per lin. ft. of trench.

The outfit was devised by H. W. Underwood, member of the firm of Field, Barker & Underwood, contractors, who was in personal charge of the work. The engineers were Remington & Vosbury, Camden, N. J. The writer was resident engineer on the job.

Very truly yours,

Camden, N. J. A. B. Depuy.

Motor Trucks on Highway Work

The Editor of Municipal Engineering:

Sir—

For power purposes on road construction in this locality motor trucks are sold. In highway maintenance and construction the work is so varied that power of this character is found to be very efficient. The truck is so constructed that it will pull heavy grading machinery and is also equipped to handle material to the best advantage. Power of this kind has two great uses in road construction; one is for handling road-grading and building machinery for dirt roads and the other is for handling materials for building and constructing special surfaced highways, and in this work we have found the motor truck a very successful machine and it covers this field well.

Very truly yours,

Topeka, Kans. H. S. Putney.

Fire Engineering

Fire Department of Harvey, Ill., Motorizes

The city of Harvey, Ill., recently installed a two-ton Harvey motor-driven combination chemical and hose truck. The machine is equipped with all of the latest and most approved starting equipment and is here illustrated.

The city of Harvey, which has a population of about 12,000, is under the commission form of government and municipal

HARVEY, ILL., COMBINATION CHEMICAL AND HOSE TRUCK.

progress has lately been rapid. The extension of the fire limits to 1½ miles more in each direction from the fire station made plain the need of more adequate protection than hitherto has been afforded by the old horse-drawn equipment.

The question of cheaper maintenance was also a determining factor that influenced Fire Chief A. Bouk and the city commissioners in making the change to motor apparatus. For ten years past the local fire department has made runs averaging 50 miles annually, and horse maintenance with feed, shoeing and incidentals in the interim was unduly heavy. Hence, the city of Harvey regards its new motor apparatus as an actual economy as well as an aid to better fire protection.

Trucks to Displace Tacoma's Horses

According to a plan recently submitted by Commissioner Pettit, of Tacoma, Wash., the horses and horse-drawn fire apparatus of that city are to be superseded by up-to-date automobile fire trucks. Quoting from a local statement:

"The Tacoma fire department is already partly supplied with motor vehicles, and there can be no question of their efficiency. It is said that part of the department now having horse-drawn vehicles has a maintenance cost of $64,154 a year. It is computed that the cost of maintenance when motorized would be 50,071 a year, which would mean a saving of about $14,000 a year in maintenance. In five years such a saving would pay back the $60,000 it is proposed to borrow for the new equipment, and interest besides. The fire department will shortly have to expend about $25,000 for horses and horse-drawn equipment unless it adopts the motorizing plan. The seven motor vehicles it is proposed to buy would, according to estimates, cost $60,000, or about $35,000 more than new horses and horse-drawn apparatus. From one point of view $35,000 is all the city would need to save by reduced cost of maintenance to prove the motor plan a public economy. Another item to be considered is the $5,000 or more the city would receive by the sale of horses and horse-drawn vehicles."

Using Dynamite to Check Fires

Many fires have been checked by the use of dynamite, notably the Atlanta fire. At Atlanta 2,000 homes had burned down when a liberal use of dynamite finally gained control of the fire. One of the expert explosive men who helped check this fire discussed wrong and correct methods as follows:

"Up to our arrival there had been burned about 50 city blocks and after we started the fire did not get out of four city blocks, three of which were dynamited by us.

"When we arrived I found the dynamite squad were attempting to dynamite the houses by tying three or four sticks of dynamite together and priming and throwing them at random into a house, the result of which was to merely shake the house and blow out the windows so that it caught fire more readily.

"I took from one to three cases of 50 per cent Red Cross extra to a house, depending on its size and solidity, and placed it as near to the center of the house as possible, on the ground floor and against the strongest wall. This brought the house down level with the ground in every case and in such shape would enable the fire company to get a stream on it at once. We shot two houses at once and used cap and fuse method."

Decatur, Ill., Has New Motor-driven Aerial Truck

C. W. Devore, fire marshal of the city of Decatur, Ill., not long ago strengthened his fire fighting equipment by the purchase of a Couple-Gear motor-driven aerial truck. The ladder, weight 850 lbs., can be either raised or lowered by one man. In a recent full hour's test of the ladder and hoist, the ladder sustained an aggregate weight of 760 lbs., the firemen being

DECATUR, ILL., MOTOR DRIVEN AERIAL TRUCK.

distributed at various heights as shown in the accompanying photograph. There was no apparent deflection or drop even under this unusual strain.

Chief Devore reports that the machine works very smoothly and is easy to operate after little practice. "It has plenty of power and speed," he says, "and the hoist is far ahead of any similar one of which I know. Certainly if we were in the market for an aerial truck, we could do no better than duplicate the machine we already have."

Progress of Motorization of Wisconsin Fire Departments

Wisconsin cities are rapidly motorizing their fire equipment. Even small cities are replacing horse-drawn apparatus with more efficient and more economically maintained modern motor equipment. The apparatus being purchased varies widely in make, combination and price. In order to be able to furnish cities contemplating the purchase of new equipment with information concerning the installations that have been made in other cities of similar size, the municipal reference bureau recently collected data along these lines and they are reported by Ford H. MacGregor, chief.

There are 39 cities in the state in which the fire departments have been fully or partially motorized.

All cities of over 5,000 population in the state, with the exception of six—Beaver Dam, Marshfield, Marinette, Oconto, Portage and South Milwaukee—have installed motor fire apparatus. The following cities of less than 5,000 population are supplied with motor equipment: Berlin, Columbus, Cudahy, Delavan, Evansville, Hudson, Lake Mills, Platteville, River Falls, Stoughton, West Bend and Whitewater.

Cities Planning Purchase.

A number of Wisconsin cities are planning to purchase motor apparatus for their fire departments in the near future. Among cities planning the immediate purchase of motor fire apparatus are: Black River Falls, Clintonville, Fort Atkinson, Horicon, Jefferson, Marinette, Monroe, Portage, Richland Center, Stanley, Tomahawk, Viroqua, Wauwatosa.

Make of Apparatus Used.

A list follows which shows the make of each machine, and how many of each are in use in Wisconsin fire departments: Ahrens-Fox, 1; American-La France, 20; Buick, 2; Carter Car, 6; Chalmers, 1; F. W. D., 1; Ford, chassis locally equipped, 5; Harder, 1; Jeffery, 8; Kissel, 3; Menomonie, 1; Mercedes, 1; Mitchell, 5; Oakland, 1; Overland, 1; Owens, 1; Palmer-Singer, 1; Seagrave, 23; Service, 1; Smith, 1; South Bend, 1; Stegeman, 3; Sterling, 1; Studebaker, equipment made by Peter Pirsch, 1; Thomas, 1; Victor, 1; White, 4; Wisconsin, 1.

As indicated by this list some cities have not bought the standard motor fire apparatus, but have had their apparatus made to order by regular automobile and motor truck manufacturers. In some cases the chassis has been purchased and the equipment made by local contractors or built by the fire department.

Digest of the Essential News

Massachusetts Takes the Hazard Out of Road Contracts

The State Highway Commission of Massachusetts is carrying on some of the road work under its charge by new forms of contracts, designed to shift to the state the burden of extensive charges for labor and materials and the responsibility for delivering materials when needed. Under existing conditions no contractor can afford to bid on extensive road work except at a price high enough to save him from loss in case labor and materials increase greatly in price. Under ordinary conditions an experienced contractor can foresee changes in such prices and allow for them, but he cannot do so at present, and consequently his bids on work are very high. It is not believed that these high prices on materials and labor will continue, and the new form of contract used in Massachusetts will enable the state to save considerable money when both labor and materials can be procured at a lower figure than the contractor now believes it safe to figure on.

First Form of Contract

Last May the state made a contract with an experienced highway contractor under which it agreed to furnish all the machinery and materials and the contractor agreed to furnish all labor, teams and small tools. The books of the contractor are kept in detail and are open to the examination of the State Highway Commission at all times. The commission pays the contractor for his labor expenditures every week or every fortnight, and it also pays for workmen's insurance. Maximum limits have been set for the pay of labor, but these can be increased by mutual agreement should necessity for doing so arise. The other expenditures of the contractor are paid back

to him monthly by the Highway Commission. The contractor receives for his overhead expenses, personal services, the use of small tools and for his profit an agreed-upon sum for each unit of work performed, these prices being made out on the basis of so many cents per cubic yard for gravel surfacing, so many cents per ton for local broken stone in place and rolled, so many cents per foot for pipe, and the like.

Second Form of Contract

Another form of contract that is used has been adopted when all bids for a job were considered too high. In such a case an arrangement has been made with the low bidder to do the work at actual cost, plus an amount for profit and overhead expenses figured on the unit of each class of work, as 7½ cents per cubic yard for excavation. Under this contract the contractor supplies labor, tools and machinery and pays his liability insurance, while the Highway Commission furnishes the materials and pays the contractor his actual expenses. If the actual cost of the work proves less than the original bid, the contractor shares the saving equally with the Highway Commission, but the contractor in no case is to receive more than his bid. Under this form of contract the state is assured that the work will not cost more than a specified sum, and if the expense of construction is less than the contractor estimated, the state will obtain the road at a lower price than the original bid.

Savannah Builders Pool Interests

The contractors, building supply men, electrical men and builders in general of Savannah are preparing to pool their interests, their labor, finances and other assets, to enable them to compete with other cities of the Southeast, where similar actions are said to have been taken, and with the wealthy Northern firms in bidding on big contracts. A number of big government contracts are in sight that Savannah firms, as individual corporations, are not able to secure. An organization to be known as the Savannah Builders Exchange is to be formed. The contractors have decided that the need of the organization is urgent.

Old Mexico Is Going In for Heavy Construction

The Mexican government has committed itself to the policy of constructing at the earliest possible time a system of modern highways that shall connect all the principal cities and ports of that country. This movement was inaugurated several weeks ago by the department of communications and public works, following the outlining of the tentative plan for construction and improvement of the highways of the country. A meeting of good roads enthusiasts from different parts of the country was held in the City of Mexico and the organization of the National Highway Association of Mexico resulted.

It also is proposed to build a modern highway to run from the City of Mexico to Vera Cruz, following the ancient highway that was built by Cortez about 400 years ago. There are still remnants of other ancient highways which were built in the days of the Conquistadores, and wherever it is possible these old camino reals, or main highways, will be rehabilitated and put to modern use. The import during the last two months of more than 5,000 motor cars is serving as a stimulus for a good roads movement.

American Association of Engineers Organizes Three New Chapters

The Board of Directors of the American Association of Engineers, at their meeting on September fifth, granted charters to the members in St. Paul, Indianapolis and Milwaukee. This makes a total of seven chapters which have been organized since the Association was incorporated about two years ago. The total enrollment of the National Organization is over twenty-two hundred different members.

A joint meeting of the association and the Detroit Engineering Society was held in the Commerce Building, Thursday, August thirtieth. It was the unanimous opinion of the engineers present that the Detroit Society should form a working co-operation with the American Association, as they have been carrying out a similar program locally for Detroit as the other organization has operated in a national way. The Detroit Society has a total enrollment of about seven hundred members and if this working co-operation is established it will mean the furthering of the work laid out by the committee on Engineering Co-operation.

Membership in the American Association of Engineers is being extended to all technical engineers in military service without payment of initiation fee or dues. This is part of the co-operative plan to keep them advised as to progress in the engineering field and to give them personal assistance upon their return to their professional work.

Federal Government Apportions $14,550,000 to Help States Build Good Roads

The Secretary of Agriculture has announced the apportionment of $14,550,000 of Federal funds to be used in the fiscal year ending June 30, 1919, by the several states in the construction and maintenance of rural post roads, as follows:

State	Sum Apportioned	State	Sum Apportioned
Alabama	$ 313,456.47	Oregon	236,332.74
Arizona	205,540.58	Pennsylvania	690,145.78
Arkansas	250,018.47	Idaho	$ 182,471.55
California	456,167.23	Illinois	658,323.48
Colorado	257,278.92	Indiana	406,230.18
Connecticut	92,216.45	Iowa	434,653.61
Delaware	24,411.99	Kansas	429,131.88
Florida	170,723.88	Kentucky	292,984.62
Georgia	403,909.45	Louisiana	203,755.29
Massachusetts	221,261.85	Maine	144,807.42
Michigan	435,356.37	Maryland	130,871.43
Minnesota	425,865.40	Rhode Island	34,972.38
Mississippi	268,751.60	South Carolina	215,014.08
Missouri	508,603.98	South Dakota	243,175.61
Montana	299,520.89	Tennessee	340,663.51
Nebraska	319,445.25	Texas	876,986.70
Nevada	193,229.82	Utah	170,763.17
New Hampshire	62,610.11	Vermont	68,128.92
New Jersey	177,357.22	Virginia	298,120.77
New Mexico	238,634.55	Washington	216,530.19
New York	749,674.20	West Virginia	159,713.89
North Carolina	342,556.47	Wisconsin	382,707.20
North Dakota	229,585.91	Wyoming	183,805.78
Ohio	558,043.42		
Oklahoma	340,489.34	Total	$14,550,000.00

This is the third apportionment under the act, $4,850,000 having been apportioned for the fiscal year ending June 30, 1917, and $9,700,000 for the fiscal year ending June 30, 1918.

Are the Railways Opposed to Waterways Development?

Many who would have favored waterway construction programs but for the feeling that strong railway lobbies would throttle all such projects at birth, should note the following extracts from a recent letter by the vice-president of the C. B. & Q. R. R. to the frieght departmeent of that prominent road:

"There is every indication that for some time to come the traffic offered for transportation in this country will be in excess of the capacity of the rail facilities which are available. I want to reiterate to you, and through you to our representatives generally, that it is the earnest desire of the management that every opportunity be taken to assist in the development of the practical use of the waterways.

"Some of the steamship people, shippers and the public

generally have in the past been inclined to the view that the railroads would by all means in their power discourage the use of water facilities by making low competitive rates and through refusal to participate in joint rates and though billing arrangements, declining to build tracks to docks, etc., and we want, if possible, to have this view changed as quickly as possible."

1917 a Great Building Year

Comparative statistics of building and engineering operations in Illinois, Indiana, Iowa, Wisconsin, Michigan and portions of Missouri and eastern Kansas, as compiled by the F. W. Dodge Company:

Contracts awarded January 1 to July 1, 1917.....	$344,419,000
Contracts awarded January 1 to July 1, 1916.....	219,237,086
Contracts awarded January 1 to July 1, 1915.....	119,020,600
Contracts awarded January 1 to July 1, 1914.....	104,656,000
Contracts awarded January 1 to July 1, 1913.....	106,531,000
Contracts awarded January 1 to July 1, 1912.....	59,402,000
Contracts awarded January 1 to July 1, 1911.....	80,822,313
Contracts awarded January 1 to July 1, 1910.....	111,958,798

Other sections of the country also made good showings. The 1918 record will probably be even better than that made in 1917.

Four Lines of Anti-Submarine Investigation

The stage at which the naval consulting board has arrived in its grapple with the problem of the submarine is outlined in the first bulletin on "The Submarine and Kindred Problems," issued recently by the board. The pamphlet is primarily intended to serve as an aid and guide to citizens who are responding to the board's request for suggestions on how the U-boat menace may be met. Thousands of such suggestions, it is stated, have been received since the board made its appeal.

The latest type of submarine in use abroad, the pamphlet states, "has a surface speed of at least seventeen knots an hour and a submerged speed of probably less than ten knots. If running near the surface the periscope might be raised, a quick observation taken, and lowered again, within thirty seconds. If, however, the submarine is on the surface and hatches uncovered, from one to four minutes will be required to completely submerge, depending upon circumstances."

Four lines of investigation to combat this instrument of destruction have been followed by the Naval Consulting Board. They are: 1. Means of discovering the approach of a hostile submarine and locating it so as to permit of prompt action for combating its attack. 2. Protection of cargo carrying ships by nets, guards and screens. 3. Protection through decreasing the visibility of vessels. 4. Methods of destroying or blinding a hostile submarine.

Meanwhile, What of the Alaska Railroad?

The government railroad in Alaska will hasten the development of that territory's vast resources; will encourage the production of foodstuffs, thus reducing the territory's dependence upon the United States for supplies; will furnish coal in unlimited quantity for the navy, obviating the necessity for the transcontinental shipment to the Pacific of fuel for government vessels, and at the same time release thousands of cars for the transportation of war materials and foodstuffs.

Purposes of Road

On March 12, 1914, the Alaskan railroad act was approved by the President. This act authorized and directed the President to locate a railroad in the Territory of Alaska not to exceed in the aggregate 1,000 miles. The purposes of the road, as set forth in that act, were as follows:

1. To connect one or more of the open Pacific Ocean harbors on the southern coast of Alaska with the navigable waters in the interior.

2. To connect with the coal fields so as best to aid in the development of the agricultural and mineral or other resources.

3. To provide transportation of coal for the army and navy, transportation of troops, munitions of war, the mails, and for other governmental and public uses, including the transportation of passengers and freight.

The primary purpose of the railroad system authorized in the act was to develop the mineral resources of Alaska, particularly its coal.

Parts Under Construction

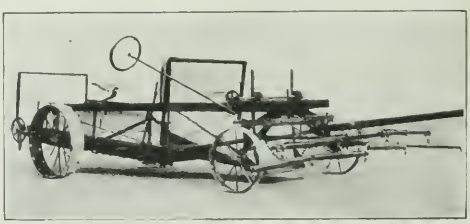
The main line of the road is now under construction from Seward, on the Pacific coast, inland for 470 miles to Fairbanks, on the Tanana river, a large and navigable tributary of the Yukon. There is now in operation 150 miles.

PLANT UNITS AND LAY OUTS

A Self-Loading and Self-Dumping Machine

The loading device on the Spaulding self-loading and self-dumping machine, here illustrated, is a part of the body. That is, it is attached to the front end of the body, and the body is pivoted on the rear axle a little back of its center. The cutter or blade is attached to the main frame of the body, is convexed and polished like a plow share, and extends back to the steel guard, which extends a little over the lower front end of the endless elevator apron, which elevates the dirt into the front end of the body. In the bottom of the body is the main endless apron, which carries the material to the rear of the body as fast as the front end is filled. The front end of the body, to which the blade is attached, is raised and lowered by a worm gear, which is under the control of the operator, and can be held to any depth desired. Both the elevator apron and the main apron are under the control of the operator, and either may be run independent of the other.

In loading the machine it is simply necessary to throw the



SELF-LOADING AND SELF-DUMPING ROAD MACHINE.

elevator in gear and lower the front end of the body until the cutting edge is the desired depth, then as the front end of the body is filled the main apron is thrown into gear as desired, until the load is completed. The front is then raised and the load is ready to be delivered. The load may be dumped in one place by a foot lever or spread while the machine is advancing 45 ft., by throwing the main apron into gear. The machine need not be stopped for any operation excepting when dumping in one place by means of the foot lever.

These machines have been tried out for over a year and have made good, it is said. They will work in sod or hard road without first plowing. They have taken up dirt out of the middle of a road that had 2 in. of frost in it. It is claimed the machine will load from 1½ to 2 cu. yds. of dirt in 20 seconds and will unload it just as quickly, either scattering it evenly over 40 ft. of roadway, or the machine can be backed up to a hole or low spot and the dirt all dumped in one pile.

Design and Use of Asphalt Pressure Distributor Wagons

Extensive use of Stanolind paving asphalt has been made in the past three years in sheet asphalt, asphaltic concrete and especially in asphalt macadam pavements and roads.

To aid in the proper construction of asphalt macadam roads, the Standard Oil Company of Indiana have built and equipped a number of asphalt pressure distributer wagons; these wagons hold about 650 gal. of asphalt and have a large fire box, and are equipped with a Westinghouse air compressor for maintaining pressure on the tank to about 40 lbs. They are used for applying the asphalt to the courses of stone on the road. It has developed from actual experience that roads constructed in this manner have proven successful and far superior to those made by the old method of applying by hand with pouring cans.

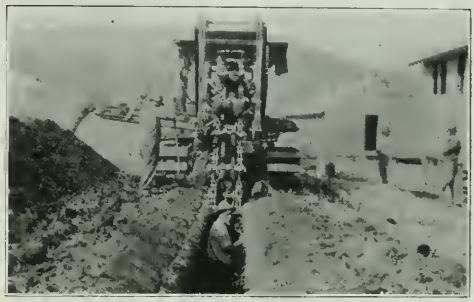
The company have specially equipped tank cars in their service for the shipping and handling of the asphalt, and the asphalt is unloaded from the tank car into the pressure distributers with the equipment contained on the wagon, which makes a very simple arrangement throughout.

The method of constructing roads with an asphalt macadam wearing surface 2½ ins. has been systematized so that the builder can start from the beginning of the road and go out over the road and return over the completed road with an empty tank wagon. This enables him to keep his work completed up to the close of each day, with the exception of possibly 100 ft. or so. In fact the road can be opened up to travel as fast as the work proceeds in putting on the 2½-in. wearing surface. One tank wagon on an average haul of one mile from the tank car to the work will complete an average of 1300 to 1600 sq. yds. of pavement a day, it is claimed. The rental for the wagons is nominal.

Ditcher Makes Good Run on Cantonment Job

Many miles of water and sewer pipe lines were constructed in quick time at each of the new cantonments for the National Army. A Pawling and Harnischfeger ditcher is here illustrated at work at the Fort Riley, Kans., cantonment. It was operated by Koehler & Thompson, excavating contractors of Kansas City, Mo., who were working for the Fuller Construction Company, the general contractors.

On this work the trenching machine made a run of 1,300



VIEW OF DITCHER CUTTING 1,300 FEET OF 5-FOOT TRENCH IN TEN HOURS.

ft. in 10 hours in a 5-ft. cut, and made several other runs nearly as good as this. The half-tone shows the machine digging a water main trench 5 ft. deep in the camp of the Thirteenth, Twentieth and Twenty-first Cavalry. It wasn't busy all the time, as the pipe-laying forces couldn't keep up with it.

STANDARD METHOD OF APPLYING ASPHALT MACADAM BY PENETRATION METHOD WITH PRESSURE DISTRIBUTOR WAGONS.

Turbine Traction Grader Makes Good Record on Chicago Streets

The Koehring turbine traction grader owned by the American Asphalt Construction Company, of Chicago, is here shown in operation on a Chicago street. This machine, recently perfected, has made a fine record on work in Chicago. This type of machine was first tested out thoroughly by the R. F. Conway Company, of Chicago, and many improvements in it were suggested by the Conway Company. They co-operated with the Koehring Machine Company in perfecting the grader. High officials of the Conway Company and of the American Asphalt Construction Company are enthusiastic over the machine in its present stage of development.

The editor is indebted to Mr. Royer, president of the American Asphalt Construction Company, for the specific data on the output of this machine here given. On July 9 of this year the performance of the grader was closely observed. That day was selected as a representative day. The machine was working in clay on the Laflin street system on the South Side

VIEW OF NEW TURBINE TRACTION GRADER.

of Chicago. A total of 624 cu. yds. of clay were handled and hauled ⅜ to ½ mile to the dump, in 1¾-yd. loads. Wagons were loaded in from 50 to 70 seconds. The working day was of nine hours. Here are the cost figures:

Item	Unit Cost	Total
17 teams at	$7.00	$119.00
1 foreman		6.00
1 operator		7.00
1 helper		3.50
2 laborers at	$3.00	6.00
Gasoline and oil		12.50
Total cost		$154.00

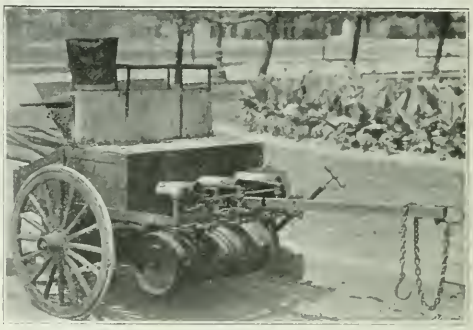
Total cost per cubic yard, 24.7 cents.

The foregoing record was made when the machine was being driven by a 32 to 34-h.p. engine, which was found too light. When a higher power engine was installed a deeper cut could be taken, and this reduced the time of loading from an average of 60 seconds to 45 seconds.

The best day's run was 610 wagon loads containing about 1½ cu. yds. each, and the cost of excavating and loading was around 4 cts. per cu. yd.

Portable Heating Furnace for Bituminous Pavement Tools

The new portable heating furnace here illustrated, of Chausse manufacture, is designed to heat tools used on bituminous pavement work. It has a battery of three burners, and produces a very hot, clean flame. It does away with the annoyance of smoke from the burning of wood and also the carting of wood and ashes. Tools can be kept hot all the time. The receptacles at the top are for buckets for the joint



NEW HEATING FURNACE FOR BITUMINOUS PAVEMENT TOOLS.

cement and the shovel. This unit is very useful in connection with asphalt paving work. Clarence A. Proctor, asphalt expert, of the Detroit Department of Public Works, has used these heating furnaces for a couple of months and considers them satisfactory. The fact that the heater is designed for the burning of oil not only makes it clean, but keeps the expense of operation low. It is so constructed that it can be transported by hitching it to an auto truck.

Using Battery of Diaphragm Pumps to Pump Tidewater

On the Coney Island Terminal job tidewater was encountered at a depth of 4 ft. in the excavation on this $3,000,000 job. Salt water flowed freely through the sandy bottom into the foundation pits. This heavy infiltration went on, of course, day and night. The Lord Construction Company put eight Atlantic diaphragm pumps on the work of keeping these

USING ATLANTIC PUMPING ENGINES ON CONEY ISLAND TERMINAL EXCAVATION.

pits unwatered until the concrete footings could be completed. The 4-in. Atlantics handled as high as 8,000 gals. per hour. They kept the pits dry until the latter were sealed with concrete and the footing complete around the pile heads. They

required little attention, as one man could look after three or four.

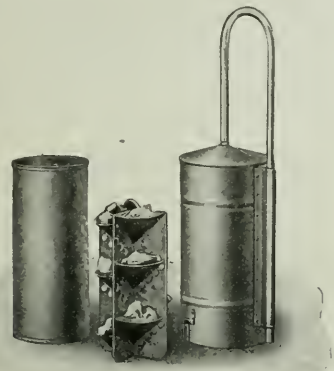
These Atlantic pumps have jump-spark ignition and are sure fire. They have easily accessible parts and are readily handled by unskilled labor. The engine and pump are mounted on a stout, easily portable steel truck, as shown in the view.

An Improved Portable Acetylene Light

A new portable acetylene light, which presents several important improvements, has just been placed on the market.

The carbide holder of this Milburn light contains twelve perforated pockets, shaped like inverted cones, arranged around a vertical axis, like a spiral stairway. This construction eliminates the possibility of overcharging and permits the use of any size carbide—a feature of economical significance.

Again, owing to this arrangement, the lights are automatic, whether burning continuously or intermittently. The moment the light is turned out the water is driven out of the carbide



NEW PORTABLE ACETYLENE LIGHT.

chamber and gas generation ceases; after generation is impossible. They require far less attention, it is claimed, than the ordinary lights; there is less waste of carbide and more even pressure, resulting in more sustained and steadier action at no increased cost; they are practically self-cleaning.

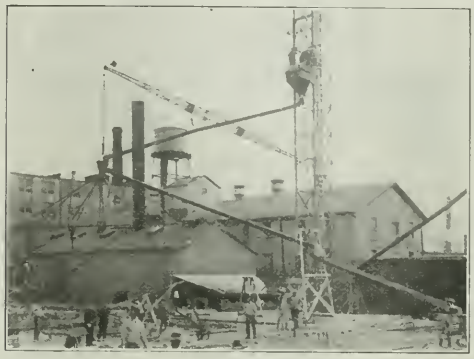
In recent government tests these lights showed a strength of 5,000 candle power for more than 12 hours on 8 lbs. of carbide—a cost of less than 3c per hour. The United States government has standardized them for the navy yards and over one-third of the government cantonments were constructed with the aid of these lights.

A Steel Tower, Open Boom, Counterweight Chute, Quick Shift, Gravity Concrete Distributing Plant

The essential time and labor-saving features of the Insley concrete distributing equipment here illustrated are emphasized in its self-defining name. While the price of steel is sky high, more of these steel hoist towers are being sold now than ever before.

It is claimed that the steel tower can be erected and dismantled in less than half the time required for a wooden hoist tower. The rigidity of alignment of the steel tower results in increased operating efficiency of entire plant. A western contractor who on one job used a steel tower and a wooden tower side by side with identical Insley equipment in each tower said that the steel tower plant showed a superior operating efficiency of about 25 per cent. It is claimed that the wood tower is good for three jobs at the outside while the steel tower lasts indefinitely.

A combination of a 50-ft. steel boom and a counterweight chute of equal length makes it possible to place concrete anywhere within a 100-ft. radius with a plant which is entirely self-supported from the tower. Many of the original users of chuting equipment have abandoned chutes in favor of buggies, owing to the trouble that was experienced in shifting the chute lines from one position to another. It is to obviate this



IMPROVED GRAVITY CONCRETE DISTRIBUTING EQUIPMENT.

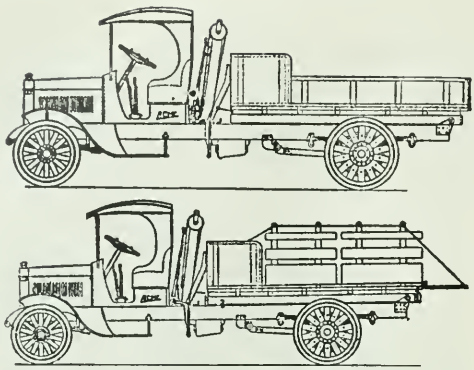
trouble that the steel boom-counterweight chute combination has been designed. If concrete is to be transported more than 100 ft. it becomes necessary to support the end of the counterweight chute with a tripod, this tripod is so low, however, that it can easily be moved.

It is claimed that the Insley quick shift feature is one of the greatest time saving devices that has ever been placed at the contractor's disposal. It consists of a steel frame which slides on the front legs of the tower, this frame carrying the tower hopper and boom supports and being moved by a manila rope shift line which runs off from the nigger-head of the hoisting engine. Whereas with the old style equipment the hopper and boom supports were bolted direct to the face of the tower, thus requiring the best part of half a day to make a change in the vertical point from which concrete was spouted, with this new quick shift equipment a change can be made within 15 minutes' time. It is therefore a case of having the concrete gang idle for 15 minutes when the pouring shifts from one elevation to another, instead of one-half a day.

A Special Combination Dump and Stake Truck Body

The special combination dump and stake motor truck here illustrated was designed to combine the advantages of the Acme all-steel dump body with those of the Acme standard stake body.

The dump body sides are constructed in the form of a substantial wooden frame lined with steel, reinforced with angles securely riveted to the steel plates. The tail gate is 15 ins. high of all-steel construction. The battlements, 24 ins. high and 30 ins. long, of one piece rolled steel plate reinforced with steel angles and four wooden stakes, unite with the dump sides in forming an inside body compartment that will dump absolutely clean. A load can be dumped in 20 seconds. The battlements, which remain stationary, are built extra strong to withstand the strains which come from lifting of load for dumping purposes. The tail gate which swings from the top is operated from the driver's seat and can be opened full width or to any angle desired. This feature makes it well adapted



CONVERTIBLE DUMP AND STAKE TRUCK BODY.

for road building purposes, as the load may be distributed evenly. When not in use as dump body, the sides are instantly removable and four side stake gates, 36 in. high, which are furnished as regular equipment, may be substituted in their place. A 24-in. wood reinforced tail gate, when lowered, extends platform length to a practical 12-ft. body for all kinds of hauling.

This body is equipped with an excellent dumping arrangement for road work whereby the truck will dump the load in a pile, or by use of a special catch on the tail gate operated from the driver's seat which allows it to open only a few inches, it will dump while the truck is in motion so that the rock is spread evenly over the surface, saving a great deal of labor in hand spreading. The general utility of this body for road work and other kinds of hauling is obvious. It will give splendid service in road building and at the same time is instantly available for all the various hauling problems which come up in contracting work where a standard stake body is desirable.

In the illustration the upper view shows a 3½ tonner with sides in place ready for use as a dump body. Lower view shows dump sides removed, stake gates and 24-in. tail gate in place ready for use as standard stake job.

Advance Information on Big Jobs

Connecticut Legislature Appropriates $6,500,000 for Road Construction

Manufacturing establishments in many Connecticut cities, notably Bridgeport, Waterbury, New Haven and Hartford, have been forced by the congested condition of the railways to employ motor trucks in making shipments within the state. This heavy traffic has developed so rapidly that the legislature has appropriated $6,500,000 for road work during the next two years, of which about $1,000,000 will be used for certain bridge and grade crossing work and the remainder will be spent at the discretion of the highway commissioner, Charles J. Bennett. He recently stated that the building of concrete, asphaltic concrete and other long-lived types of pavements will be continued. In a town near Hartford he is constructing a mile sheet asphalt on a 5-in. concrete base, because the intensity of the motor car traffic demanded a durable city street pavement and the availability of a Hartford contractor's experience and construction plant made this type the most suitable and economical.

Essential Elements in the Great Illinois Road Building Program

The greatest road building program in any state of the Union at the present is that in Illinois. It not only calls for building about 4,000 miles of hard surfaced roads, but it provides for the construction of this great mileage without any taxes on real estate. The project was worked out so as not to interfere with road building by the counties and townships and to enable the state to utilize in the most economical manner the financial aid and technical assistance which the federal government will give to Illinois under the federal aid road law of 1916.

A Real State Project

The improvement of these 4,000 miles will result in the betterment by the state of barely 4 per cent of its highways. Consequently the planning of these roads, so as to be of unquestionable benefit to the entire state and therefore a justifiable object upon which to spend state money, received long, careful study. It was necessary to afford the greatest good to the greatest number of people, to give careful attention to the cost of competitive routes and to distribute the expenditure over the state in such a way that no section could claim with fairness that it was treated inequitably. The network of state roads passes through every county in the state and connects all of the leading towns. It is not merely a matter of a few north and south roads intersected by a few east and west roads; it was laid out to meet the traffic needs of the state rather than to conform with the points of the compass.

Raising the Money

The most interesting feature of the project is the method of raising the money for the work. It is proposed to issue bonds which will be paid off from the proceeds of automobile taxation exclusively. Prolonged study of the use of improved roads has convinced the state officials that such a state-wide system of highways will be used so extensively by automobiles and trucks that the cost of the improvements should be borne by the owners of such vehicles. At present the license fee for cars ranges from $3 for 10 horse power or less to $10 for 50 horse power. Next year the taxes will be increased so that the limits will be $4.50 to $20, and in 1920 they will be increased to $6 and $25. The present motorcycle fee of $2 will be increased to $3 in 1918 and $4 in 1920. The fee for electric vehicles up to 20 tons capacity is now $5. This will be increased to $10 next year and $12 in 1920. Electric vehicles of over 2 tons pay double these fees, except in 1920 when the license will be $25.

It is proposed to begin issuing bonds in 1920, putting out $10,000,000 in that year, and to make a similar issue annually until the total bonded indebtedness is $60,000,000. It is proposed to let the first contract in 1920. In that year it is estimated that the license fees will amount to $4,800,000. The state officials estimate that in 1944 the fees will amount to $6,000,000, and both principal and interest will have been paid.

The interest rate which is proposed for the bonds is 3½ per cent.

Vote in November

Next November the electors of the state will vote on this project. It is unique in many respects, not only financially but also from an engineering point of view. Heretofore there has been pronounced opposition in some states to placing the cost of the construction of roads on motor owners exclusively. The opposition is not so strong now as it was. The automobile owner has learned, provided he keeps a detailed expense account for his machine, that improved roads not only enable him to get more service from his car or truck but also reduce materially the cost of operating and maintaining it. Any owner of a motor car can rest assured that the increased license fees proposed in Illinois, which will not be at all high at their maximum limit in 1920, will not only give all the advantages of better roads to travel over, but will also save money in the cost per mile of running his car.

Projects Embraced in the Program for Expanding Seattle Municipal Water System

The various projects embraced in the program for the expansion of the Seattle municipal water system and the contemplated order of their development are described authoritatively by Joseph Jacobs as follows:

1. Swan Lake Project

This contemplates the conversion of Swan Lake, which lies about midway between the present intake at Landsburg and the south city limits, intoo a storage reservoir at about 4,200,000,000 gals. capacity. In the event of an accident to the pipe lines above the reservoir it would afford an undiminished water supply to the city, at its present population and present rate of consumption, for a period of 100 days and for a longer period if emergency imposed the necessity of restricted usage. The plans provide for the construction of two small dams which will permit a 20-ft. rise of water above present lake level and the construction of outlet works consisting of an intake tower at the lake, a concrete lined outlet tunnel two miles long and of 150,000,000 gals. per day capacity, and a controlling tower at the lower end of this tunnel. The estimated cost of this development is $950,000 for construction and $300,000 for rights of way, or a total of $1,250,000. *The right of way purchases have practically been consumated and it is anticipated that bids for some features of the construction work will be called for within 90 days.*

2. No. 3 Pipe Line Project

This contemplates the construction of a pipe line of 50,000,000 gals. per day capacity extending along the route of the existing pipe lines from the lower end of the Swan Lake outlet tunnel, a distance of six miles to the south city boundary, where a controlling tower for all the pipe lines will be built, thence a distance of ten miles to Volunteer Park. It will be recalled that our No. 1 pipe line is now practically renewed and that our No. 2 pipe line is in such condition as to make preparation for its renewal within a few years imperative. This new pipe line will permit the No. 2 pipe line to be retired or renewed without embarrassment to a continuous full delivery of water to consumers. The estimated cost of this improvement is tentatively placed at $2,000,000, the present unstable prices of materials of construction making close estimating impossible as it also makes difficult a selection of the most desirable pipe material to be used.

3. Volunteer Park Project

This contemplates the enlargement of Volunteer Park reservoir from a single basin of 23,000,000 gals. capacity to a double basin of 60,000,000 gals. capacity, the extension being to the north of the existing basin. The location of this reservoir in the very center of the city makes it one of the most important units in our water supply protective system and it is therefore important that it be of large capacity. The present reservoir is unquestionably too small. The estimated cost of this improvement is $350,000.

4. West Seattle Project

This contemplates the construction of a pipe line of 50,000,000 gals. per day capacity extending from the proposed controlling tower at the south city boundary a distance of five miles to a commanding site in West Seattle, where a two-basin reservoir of an aggregate capacity of 220,000,000 gals. is to be constructed. This development will not only meet all future requirements of West Seattle, but will also protect our downtown district and will guarantee a safe water supply for the rapidly expanding industrial district south of Elliott Bay. The cost of this development has not yet been carefully estimated, but it may be placed roughly at $1,800,000. The necessary rights of way are now being secured.

5. Headworks Project.

This contemplates, though not for several years, the construction of a new dam and headworks at Landsburg. No definite plans nor cost estimates have yet been prepared for this project.

With the additional storage which these projects provide Seattle will have, within its immediate boundaries and extending along the north and south crest line of the city, a series of reservoirs whose aggregate capacity will be 523,000,000 gals. We have already indicated the beneficent function of Swan Lake with respect to the possible failure of the aqueduct above that reservoir and in like manner, in the contingency of disaster to the pipe lines between Swan Lake and the city, these well distributed interior reservoirs would afford a safe water supply for a city of half a million people for a period of two weeks.

There can be no doubt that these proposed developments are all desirable and that they must sooner or later be carried out if we would keep abreast of our requirements. The full consummation of the program will entail a cost aggregating approximately $5,500,000 and the only legitimate query concerning it at this time relates, not to the general merit of the scheme, but to the speed of its prosecution and to its bearing on taxes and city finance. The present plan is to issue utility bonds for these improvements, the first and immediate issue to be in the sum of $3,500,000. It is hoped that these expenditures will not necessitate an increase in water rates, but if such increase does become necessary its initial form will probably be toward equalizing the present disparity in rates charged the manufacturer and those charged the small home consumer.

The immediate undertaking of some of the elements of the general plan, as for instance the new pipe line, cannot well be deferred.

How to Drive Concrete Piles

The report of the American Railway Engineering Association on concrete piles includes a specification for driving that contains the following requirements: Piles shall be driven with a cushion cap; piles shall preferably be driven with a steam hammer; when a drop hammer is permitted it must be heavy, with a small drop; on sloping ground a hole shall be dug for the location of each pile; piles driven out of plumb more than ½ in. per foot must be pulled and redriven, if required; for working loads of 15 tons piles must be driven to a penetration of 2 in. in the last five blows with a No. 1 Vulcan steam hammer; for loads of 25 tons they must be driven to a penetration of 2 in. in the last eight blows with the same hammer; piles must not be handled on skids or moved to site before they are 28 days old.

Lights and Shades

The Lumber Jack on Railroad Construction

A. B. Carson, of The American Lumberman, sends us this French Canuck poem. Thanks, A. B.

My name is Joe le Flambeau.
I come from Canadaw.
I swing de canthook on de log
From Sault to Saginaw.
You bet your life de lumberjack
Dey all stan' roun' an' look
When Joe le Flambeau mounts de log
An' swings dat ol' canthook.

I work t'ree year for Bunyan—
Paul Bunyan, dat's de guy.
We work all winter on one pine,
De trees dey is so high.
Ten t'ousand men we had in camp,
So sure as you are born.
It took ten of de bigges' mans
To blow de dinner horn.

An' when de tam for lunch come roun'
Each man look at de moon.
De chore boy carry lunch dat year
In a grat beeg gas balloon.
An' when de mans come in at night
I tell you it was great.
To wait on all dose man in tam
De cook wear roller skate.

One winter when I work for Paul
De snow she was so deep
We cut de tree down from de top
An' haul heem up wit' sweep.
We sleep all Sunday in de camp
An' den work day an' night,
An' when we come to skid de log
We use a great beeg kite.

Den Paul shes go to Louisan',
An' me, I go wit' heem.
To clear a road across de swamp
We use five t'ousand team.
De alligat' she was so teek
Paul scratch hees head an' cry,
"We build a railroad an' we use
De alligat' for tie."

We capture all de alligat'
An' spike down all de rails.
De heads dey's lookin' all one way
An' all one way de tails.
But when we put de heads one way
We mak' one beeg mistak'.
We get hup in de mornin'
An' de railroad's in de lak'.

Seeing Things

Two laborers of color were tapping the trench bottom with their picks. Said one: "Tom, why don't you leave this place and travel? I've worked my way from New York to Frisco and from Chicago to New Orleans and I've seen the country. Why don't you travel and see the world?" A look of toleration came over the face of Tom. Said he: "Bill, has yo' ever had de D. T's.?" "No," said Bill. "Well, den," said Tom, "yo' ain't never seen nothin'—nothin' a tall."—J. B. K., New Orleans, La.

American Engineers Welcome in Berlin (?)

According to a recent number of the Proceedings of the American Society of Civil Engineers, among the societies to which members of the American Society will be welcome is the Architekten-Verein zu Berlin, Wilhelmstraase 92, Berlin, Germany. A similar welcome is said to be awaiting American engineers by the Sachsischer Ingenieur und Architekten-Verein of Dresden. Well, we shall soon see!

Forcing a Favorable Decision

A certain sales engineer travels in the South and is as energetic in all things as in selling. Some time ago he met a girl, as he frequently did, and proposed to her just three hours later. He didn't make the sale, but his follow-up was a hummer. When he reached her town he 'phoned his arrival. (He had previously ordered flowers sent to her house.) Then an invitation to dinner, the theater, then a late lunch, after which he always renewed his offer of marriage. This went on for nearly three years, and she hadn't accepted him. He grew desperate. He planned a knockout. The familiar program was followed, but on a more luxurious scale than ever before. After the late lunch they started to take a cab to her home, as usual, and eleven cabmen, all experienced on similar trips, applied for the job of driving them out. He hired them all and the procession started. Let him tell the rest of the story:

"As we swung into the street the procession formed. She saw it, and began expostulating, 'All those cabs can't drive out to my home. What will the neighbors think? Why, every one will think we are coming home drunk or crazy. What do you mean by it, Jack?'

"I just laid my hand on hers and said: 'Just a minute, Honey. There's a good reason for it. I've known you for over three years now, and I've always given you the best of everything. I've sent you enough flowers to fill a greenhouse. I sent you tons of candy. Maybe some of it was stale, but it was meant to be good and had a good brand on it. I've taken you to the best shows and bought the best seats the scalpers could give me. I've bought you enough dinners to keep a family for a year, and I've tried to sell you a life interest in a man I think is all wool and a yard wide, but you can't see it. Everything I have ever done for you has been done the very best way I know how. But after to-night you're dead as far as I am concerned, and I'm giving you the best funeral I know how. I've got every available carriage in town.'

"She looked dumfounded for a second—her face was a study. Then she began to laugh. She grabbed my hand with both hers and said, 'Jack, you're such a good loser I want you. Tell the rest of those carriages to go back and we will go out and tell the folks.'"

HOW THE CONTRACTORS ARE BIDDING

Bridge Bids Received on Contracts Awarded in August by Illinois Highway Department

Table I herewith gives data on bridges for which contracts were let during the month of August upon plans prepared for the Division of Highways of the Department of Public Works and Buildings of the State of Illinois. This tabulation is complete so far as the results of bridge lettings had been reported to the Division of Highways on August 31 by the county superintendents of highways.

In a letter to the editor relative to the work and the tabulation, Clifford Older, Bridge Engineer, said:

"The location, size and quantities are given for each bridge;

TABLE 1—BIDS RECEIVED ON ILLINOIS HIGHWAY BRIDGES DURING AUGUST, 1917.

Name of Bridge	Township	County	Span Ft.	Roadway Ft.	Height Overall Ft.	Concrete Cu. Yds.	Reinforcing Steel Lbs.	Estimated Cost $	Bids Received $
Foehner	Burgess	Bond	6	20	Box Culvert	18.0	1,390	285)	
McHugh	Tomako	Bond	9	18	Box	29.9	2,170	475)	1.215
Mills	Tomako	Bond	8	20	Box	29.2	1,650	445)	
Cemetery	Locust	Christian	10	24	Box	44.5	4,180	800)	(2,109
McCluskey	Locust	Christian	12	24	Box	82.6	6,480	1,380)	(2,175
									(2,432
Bolivia	Mt. Auburn	Christian	One abutment only		23	80.8	6,290	1,650	(1,830
									(1,900
									(1,528
Cox	Pana	Christian	18	16	11	49.6	4,610	1,010)	(1,635
Goffinett	Pana	Christian	4	24	Box	9.8	975	200)	(1,783
Stock	Pana	Christian	8	24	Box	19.2	2,460	430)	(1,543
									(1,488
Kinderdine Ford	Melrose	Clark	2@40	16	17	290.8	23,130	5,170	(5,099
									(5,170
Duffey	State Aid Route 7	Effingham	2@50	16	34	686.1	71,890	14,500	14.500
			Steel I beams				in abutments		(2,350
Emerick	Bear Grove	Fayette	30	16	13	80.2	3,710	2,390	(2,194
									(2,140
									(2,249
									(605
Peters	Laclede	Fayette	14	20	8	33.8	3,580	680	(620
									(640
Holman	Lone Grove	Fayette	20	16	9'-8"	49.2	5,060	1,030	(975
									(990
Warren	Lone Grove	Fayette	10	20	Box	33.0	2,830	650	(595
									(620
Anderson	Ramsey	Fayette	Abutments only		11'-3"	38.3	1,900	700)	(1,957
Jones Corner	Ramsey	Fayette	14	16	12½	55.1	4,080	1,110)	(1,966
Williams	Crouch	Hamilton	Abutments only		10	25.6	1,310	530	500
Snicker	Dahlgren	Hamilton	Abutments only		13	41.9	2,330	790	(738
									(785
									(1,591
Brummer	Piasa	Jersey	35	16	13	86.1	11,630	1,830	(1,675
									(1,796
Grafton	Quarry	Jersey	5	24	Box	23.2	1,280	330	(406
									(476
No. 18	Richwood	Jersey	5	24	Box	21.4	2,890	450	(442
									(550
			Steel I beams				in abutments		
Crews	Allison	Lawrence	40	20	17	95.2	4,490	4,830	4,626
									(1,180
Antioc	South Palmyra	Macoupin	Abutments only		12	59.8	0	1,160	(1,158
									(1,020
Frampton	Alma	Marion	16	16	9½	43.6	3,880	880	830
Jacobs	Alma	Marion	10	18	Box	47.5	3,200	815	800
Coffin	Alma	Marion	20	20	11½	59.5	6,620	1,185	1,120
									(1,560
Arnold	Foster	Marion	26	20	11	69.6	9,610	1,700	(1,620
									(1,700
Thomas	Iuka	Marion	10	18	Box	41.8	2,930	745	711
Kitzmiller	Brookville	Ogle	10	24	Box	33.6	3,020	610	549
Meyers	Littleton	Schuyler	45	18	15	140.7	19,440	3,190)	(5,150
Newell	Littleton	Schuyler	8	20	Box	52.5	4,430	1,020)	(
Little Flock	Littleton	Schuyler	12	16	13'-9"	68.6	3,810	1,080)	(5,274
			Steel truss						(14,600
									(14,700
Van Scyoc Ford	Kansas	Woodford	125	16	25	202.5	8,950	13,750	(13,213
									(13,999
									(13,085
Bali	Hutsonville	Crawford	55	16	21½	228.2	27,530	4,540	4,747
Lindley	Hutsonville	Crawford	50	16	23	234.4	26,120	4,610	5,000

also the estimated cost as prepared by this department, and a list of the bids received.

"For small bridges we are not having any difficulty in letting contracts at prices which are generally very close to the estimated cost.

"During the past few months we have found that there is not very much competition among contractors for the large jobs. This is undoubtedly due, in a large measure, to the unsettled labor conditions. The conditions governing the cost of the bridges given in this tabulation, such as cost of materials, length of haul, nature and depth of excavation, etc., cover so wide a range that it is impossible to give all of this information in a tabulation of this kind."

Information to Bidders.

The Highway Department maintains a list of contractors who want to bid on Illinois highway bridges and mimeographed notices are sent to this list relative to each bridge letting. The notice contains information relative to the time and place of receiving bids, etc. A specimen notice, that relating to the Cox, Goffinett and Stock Bridges mentioned in Table I is here given:

STATE OF ILLINOIS
Department of Public Works and Buildings
DIVISION OF HIGHWAYS

PROPOSED BRIDGE CONSTRUCTION

Note:—The following information is believed to be correct and is furnished for the convenience of bidders who wish to make mailed bidds, but the Division of Highways assumes no responsibility for, nor guarantees as correct, any of the statements made herein.

ADVERTISEMENT.
HIGHWAY NOTICE—PUBLIC LETTING OF CONTRACT.

Notice is hereby given that sealed bids will be received for the following described bridge work at the time and place indicated below.

More detailed information may be had by an examination of the plans and specifications prepared by the Division of Highways, which may be seen at the office of the county superintendent of highways, or may be obtained upon application in writing from Clifford Older, bridge engineer, Division of Highways, Springfield, Ill.

Bids will be received up to 10:00 o'clock a. m., August 24, 1917, at the Town Hall in Pana, Ill., for the construction of three reinforced concrete bridges to be built in Pana township, Christian county. C. A. Penington, Co. Supt. of Highways, Taylorville, Ill.

Cox, Goffinett and Stock Bridges: Spans 18, 4 and 8 feet; roadways 16, 24 and 24 feet; height over all 11, 5½ and 7 feet. Estimated total concrete 49.6, 9.8 and 19.2 cubic yards; reinforcing steel 4610, 975 and 2460 pounds.

Nearest railroad station, Pana, 3¾ and 4 miles, and Millersville, 1 mile.

Materials for concreting must be shipped in.

All three bridges to be located on a new road. No present structures.

At site of Cox bridge, low water flow 2 inches deep, 10 feet wide; high water 6½ feet deep.

Average depth of excavation at Cox Bridge about 10 feet in clay to extend about 4 feet below stream bed. Excavation in clay at sites of Goffinett and Stock bridges to extend about 3 feet below stream bed for head-walls.

Work to be completed on or before November 15, 1917.

Engineer's estimate for three bridges $1,640.00.

Springfield, Ill., August 14, 1917.

The Low Bids Received by Ohio State Highway Department on Sept. 7 at $1,338,516 Letting Covering 66.86 Miles New State Aid Roads

The estimated cost of the 66.86 miles of new state aid road work on which bids were asked by the Ohio State Highway Department on September 7 was $1,338,516.68. The names of the low bidders, the amount of their bids and a brief description of the work bid on are here given. On some of the jobs scheduled no bids were received and others were cancelled—these are omitted from this article. The editor is indebted for this information to Clinton Cowen, State Highway Commissioner. The figures in parentheses following "bridges and culverts" is the engineer's estimate on this item.

Road 1—Adams Co. on Sec. B of the West Union-Hillsboro Road, in Wayne Twp. For grading, paving with water-bound macadam and constructing bridges and culverts. ($1,938.) Width of pavement, 14 ft. Roadway, 24 ft. Length, 5,580 ft., or 1.06 miles. Estimated cost, $9,211.50. Date set for completion, Dec. 15, 1917. Low bidder, Thomas Dalton, Winchester, Ohio; $9,211.50.

Road 2—Adams Co. on Sec. C-2 of the West Union-Sinking Spring Road, in Meigs Twp. For grading, paving with water-bound macadam and constructing culverts. ($807.) Width of pavement, 14 ft. Roadway, 24 ft. Length, 7,000 ft. or 1.33 miles. Est. cost, $8,500.24. Date completion, Dec. 15, 1917. Low bidder, J. M. Day & Co., Peebles, Ohio; $8,500.22.

Road 4—Butler Co. on Sec. I of the Hamilton-Middletown Road, in Lemon Twp. For constructing bridges and culverts ($3,275), grading roadway and paving with one of the following types:

Monolithic Brick $75,964.15
Reinforced Concrete 67,934.75

Width: Pavement, 16 ft. Roadway, 26 ft. Length, 16,803 ft., or 3.18 miles. Date completion, Aug. 1, 1918. Low bidders: P. J. Connell, Cambridge City, Ind., monolithic brick, $76,964.15; Strodbeck Brothers, Middletown, Ohio, reinforced concrete, $67,984.75.

Road 5—Butler Co. on Sec. J of the Hamilton-Middletown Road, in Lemon Twp. For constructing bridges and culverts ($3,390), grading roadway and paving with one of the following types:

Monolithic Brick $81,874.95
Reinforced Concrete 71,624.85

Width: Pavement, 16 ft. Roadway, 26 ft. Length, 18,700 ft., or 3.54 miles. Date completion, Aug. 1, 1918. Low bidder on monolithic brick, P. J. Connell, Cambridge City, Ind., $81,874.95. No bid on reinforced concrete.

Road 8—Delaware Co. on Sec. A of the Delaware-Prospect Road, in Delaware Twp. For constructing bridges and culverts ($3,842), grading roadway and paving with one of the following types:

Reinforced concrete: Width: Pavement, 16 ft. Roadway, 26 ft. Length, 12,000 ft., or 2.27 miles. Est. cost $60,121.91
Bituminous concrete: Width: Pavement 16 ft. Roadway, 26 ft. Length, 12,000 ft., or 2.27 miles. Est. cost 63,847.61
Bituminous macadam: Width: Pavement, 16 ft. Roadway, 26 ft. Length, 12,000 ft., or 2.27 miles. Est. cost 41,530.01

Date completion, July 1, 1918.

Low bidders: The Delaware Blue Limestone Contracting Co., Delaware, Ohio, reinforced concrete, $56,702.71. Federal Asphalt Paving Co., Hamilton, O., bituminous concrete, $63,700.

Road 9—Green Co. on Sec. I of the Wilmington-Xenia Road, in Caesar Creek Twp. For constructing bridges and culverts ($6,515), grading roadway and paving with waterbound macadam. Width of pavement, 14 ft. Roadway, 26 ft. Length,

26,659 ft., or 5.05 miles. Est. cost of construction, $56,652.79. Date completion, July 1, 1918. Low bidder, The Wilson Engineering and Contracting Co., Xenia, O., $55,587.

Road 11—Hancock Co. on Sec. A-1 of the Ottawa-Findlay Road, in Liberty Twp. For grading roadway, constructing bridges and culverts ($2,393) and paving with one of the following types:

Reinforced Concrete: Width of pavement, 16 ft. Roadway, 26 ft. Length, 6,758 ft., or 1.28 miles. Est. cost $27,304.92

Brick: Width of pavement, 16 ft. Roadway, 26 ft. Length, 6,758 ft., or 1.28 miles. Est. cost..... 37,417.33

Asphalt Concrete: Width of pavement, 16 ft. Roadway, 26 ft. Length, 6,758 ft., or 1.28 miles. Est. cost 31,718.67

Date completion, July 1, 1918. Low bidder, C. G. Withan, Deshler, O., brick, $36,500. No bids on concrete.

Road 13—Highland Co. on Sec. H of the Allenburg-Lynchburg Road, in Dodson Twp. For grading, paving with waterbound macadam and constructing culverts ($1,083). Width of pavement, 12 ft. Roadway, 24 ft. Length, 7,562 ft., or 1.43 miles. Est. cost, $11,743.83. Date completion, Dec. 15, 1917. Low bidder, C. A. Lunsford, Hillsboro, O., $11,643.

Road 20—Mahoning Co. on Sec. R-1 of the Akron-Youngstown Road, in Jackson Twp. For grading roadway, constructing bridges and culverts and paving with waterbound macadam. Width of pavement, 16 ft. Roadway, 26 ft. Length, 5,167 ft., or .98 mile. Est. cost, $12,146.60. Date completion, Dec. 15, 1917. Low bidder, L. H. Young Contracting Co., West Austintown, O., $12,054.74.

Road 21—Mahoning Co. on Sec. P of the Akron-Youngstown Road, in Austintown Twp. For grading roadway and paving with brick. Width of Pavement, 16 ft. Roadway, 26 ft. Length, 5,893 ft., or 1.11 miles. Est. cost, $26,120.85. Date completion, Dec. 15, 1917. Low bidder, L. H. Young Contracting Co., West Austintown, O., $25,483.23.

Road 23—Mercer Co. on Sec. E-1 of the Ft. Recovery-Minister Road, in Marion Twp. For grading the roadway, constructing bridges and culverts ($1,304) and paving with concrete. Width of pavement, 16 ft. Roadway, 26 ft. Length, 6,418 ft., or 1.22 miles. Est. cost, $31,210.03. Date completion, 75 per cent. Nov. 1, 1917, 100 per cent. June 15, 1918. Low bidder, Burnett & Christian, Rockford, O., $30,069.03.

Road 24—Monroe Co. on Sec. N of the Ohio River Road, in Ohio Twp. For grading and constructing drainage structures ($6,045). Roadway, 26 ft. Length, 4,988 ft., or 0.95 mile. Est. cost, $15,166.38. Date completion, July 1, 1918. Low bidder, V. Mange, Niles, O., $12,100.72.

Road 25—Muskingum Co. on Sec. L of the Zanesville-Cincinnati Road, in Newton Twp. For grading, constructing drainage constructions ($793) and paving with bituminous bound macadam. Width of pavement, 16 ft. Roadway, 26 ft. Length, 4,280 ft., or 0.82 miles. Est. cost, $15,183.48. Date completion, June 15, 1918. Low bidder, The J. A. Sevingle Constructing Co., Zanesville, O., $15,182.

Road 26—Pickaway Co. on Sec. L-1 of the Lancaster-Circleville Northern Road, in Walnut Twp. For grading roadway, constructing bridges and culverts ($1,357) and paving with waterbound macadam. Width of pavement, 16 ft. Roadway, 26 ft. Length, 7,250 ft., or 1.37 miles. Est. cost, $24,109.27. Date completion, June 30, 1918. Low bidder, John S. Neff, Circleville, O., $22,099.27.

Roadway 27—Portage Co. on Sec. V of the Akron-Youngstown Road, in Edinburg Twp. For grading roadway, constructing bridges and culverts ($5,455) and paving with one of the following types:

Concrete. Width: Pavement, 12 ft. Roadway, 26 ft. Length, 13,682 ft., or 2.59 miles. Est. cost..... $46,932.43

Bituminous Macadam. Width: Pavement, 14 ft. Roadway, 26 ft. Length, 13,682 ft., or 2.59 miles. Est. cost 42,618.56

Monolithic Brick. Width: Pavement, 12 ft. Roadway, 26 ft. Length, 13,682 ft., or 2.59 miles. Est. cost 59,656.12

Date completion, June 15, 1918. Low bidder, L. Garrett, Kent, O. Concrete $46,841.55; monolithic brick, $59,640.37.

Road 28—Preble Co. on Sec. C-2 of the Hamilton-Eaton Road, in Gasper Twp. For grading, paving with bituminous macadam and constructing culverts ($100). Width of pavement, 16 ft. Roadway, 26 ft. Length, 2,800 ft., or 0.52 miles. Est. cost, $8,147.90. Date completion, Dec. 1, 1917. Low bidder, Hamilton & Bunger, Eldorado, O., $8,069.62.

Road 30—Ross Co. on Sec. N and n of the Chillicothe-Lancaster Road, in Green Twp. Contract No. 1: For grading roadway, constructing bridges and culverts ($170) and paving with semi-monolithic brick. Width of pavement, 13 and 16 ft. Roadway, 26 ft. Length, 3,489 ft., or 0.66 mile. Est. cost, $15,810.76. Contract No. 2: For grading roadway, constructing bridges and culverts ($549) and paving with semi-monolithic brick. Width of pavement, 3, 16, 30 and 50 ft. Roadway, 26, 40 and 60 ft. Length, 3,585 ft., or 0.68 mile. Est. cost, $28,848.83. Date completion, Dec. 15, 1917. Low bidder, Brewer, Tomlinson & Brewer, Chillicothe, O. Con. No. 1, $15,633.52. Con. No. 2, $28,538.66.

Road 31—Shelby Co. on Sec. B-1 of the Piqua-St. Marys Road, in Loramie Twp. For grading the roadway, constructing bridges and culverts ($513) and paving with one of the following types:

Brick. Width: Pavement, 16 ft. Roadway, 26 and 29 ft. Length, 4,960 ft., or 0.94 mile. Est. cost... $31,814.41

Monolithic Brick. Width: Pavement, 16 ft. Roadway, 26 ft. Length, 4,960 ft., or 0.94 mile. Est. cost 24,495.10

Reinforced Concrete. Width of pavement, 16 ft. Roadway, 26 ft. Length, 4,960 ft., or 0.94 mile. Est. cost 24,061.30

Date completion, Dec. 1, 1917. Low bidders: Edward Paul, Chas. L. Bozer and F. P. Elsass, Botkins, O., reinf. conc., $23,821.27. Isaac Putnam and Peter Shingledecker, Van Wert, O., reinf. conc., $23,193.70.

Road 32—Stark Co. on Sec. G of the Ravenna-Louisville Road, in Marlboro, Twp. For grading roadway, constructing bridges and culverts ($1,679) and paving with one of the following types:

Bituminous Macadam, Limestone Top Course. Width: Pavement, 16 ft. Roadway, 26 ft., or 2.52 miles. Est. cost..... $54,571.07

Bituminous Macadam, Slag Top Course. Width: Pavement, 16 ft. Roadway, 26 ft. Length, 13,300 ft., or 2.52 miles. Est. cost..... $54,571.07

Date completion, July 1, 1918. Low bidder, Seiple & Wolfe Construction Co., Youngstown, O. Bit. macadam, limestone top, $54,335.03.

Road 35—Union Co. on Sec. B of the Marysville-Kenton Road, in Paris Twp. For grading the roadway, constructing bridges and culverts ($1,734) and paving with waterbound macadam. Width of pavement, 16 ft. Roadway, 26 ft. Length, 15,231 ft., or 2.88 miles. Est. cost, $35,800.55. Date completion, 60 per cent. Dec. 1, 1917; 100 per cent. July 1, 1918. Low bidder, S. Baughman, Marysville, O., $33,506.61.

Road 39—Warren Co. on Sec. B of the Cincinnati-Chillicothe Road, in Harlan Twp. For grading, paving with waterbound macadam and constructing culverts ($2,852). Width of pavement, 14 ft. Length, 513 ft., or 0.10 mile. Est. cost, $3,793.70. Date completion, Nov. 15, 1917. Low bidder, Welden N. McKay, New Burlington, O., $3,789.

Personal Items

George M. Gadsby, formerly superintendent of the Arkansas Water Company at Little Rock, but who for several years was connected with the American Water Works and Electric Company of New York, has accepted a position as assistant to the superintendent of the company with which he is now connected. He is a graduate of the Massachusetts Institute of Technology and was at one time superintendent of the Warren Water Company at Warren, Pa.; the American Water Works and Guarantee Company at Pittsburgh, Pa.; the Arkansas Water Company at Little Rock, and the American Water Works and Electric Company at New York.

William H. Connell, former chief of the bureau of highways and street cleaning of the city of Philadelphia, has resigned that position to become engineer executive of Day & Zimmerman, Inc., Engineers, 611 Chestnut St., Philadelphia. The company will advise on engineering, administrative and financial problems connected with the construction and maintenance of roads and pavements, street cleaning and the removal and disposal of municipal waste.

Thomas A. Lowe of Buffalo, N. Y., superintending engineer for the Larkin & Sangster Company, causeway reconstruction contractors, has gone to Galveston, Texas, and is making preliminary plans for carrying out the work.

James C. Nagle has been appointed dean of engineering and professor of civil engineering of the Agricultural and Mechanical College of Texas, to succeed D. W. Spencer, who died in June. Dean Nagle is well known to civil engineers who have used his book on railroad location as a college and field text book.

W. B. Reed, formerly assistant city engineer of Roanoke, Va., has been named city manager of Portsmouth, Va., on a three-year contract, paying $4,000 for the first year, $4,500 for the second and $5,000 for the third.

M. L. Morris, former city engineer of Great Falls, Mont., has been appointed by the city council as superintendent of water works in that city at $250 a month.

Robert Elliott, for some years commissioner of water works in Nashville, Tenn., is up for re-election and his candidacy has been endorsed by the Nashville Real Estate Exchange.

Professor Milo S. Ketchum, dean of the College of Engineering of the University of Colorado, was elected superintendent of the Society for the Promotion of Engineering Education, at the recent annual meeting of the society. He is a graduate of the University of Illinois and was a member of the civil engineering faculty at that institution for a number of years. He is author of several well-known engineering text books.

E. N. Vail is in charge of the new offices of the New Jersey state highway department at Plainfield. This is headquarters of the northern division.

A. Baldwin Wood, an engineer of the sewerage and water board of the city of New Orleans, has been made consulting engineer of the sanitary district of Chicago and will hereafter serve both cities.

Caleb Mills Saville, for some years chief engineer of the water works at Hartford, Conn., has assumed the manager's duties as well. He has now under his charge all matters relating to engineering construction, extension, supervision, care and management of the water system. Formerly, for a period of ten years, he was division engineer of the Metropolitan water board of Massachusetts in Boston district, and for four years was engineer in charge of the third division on the Panama canal construction. His work at Panama was greatly admired by the engineering profession.

William Smith has been appointed city engineer of Jackson, Ky., succeeding Henry Dunneen.

George Wells has been appointed county engineer of highways for Pike county, Ky.

City Manager Frank J. Boland of San Rafael, Cal., has been given a captain's commission in the United States army engineering corps, and has reported for duty at the Presidio in San Francisco. On his return from military service he will resume his office of city manager of San Rafael.

C. C. Cottrell has been appointed assistant highway engineer of Nevada, with headquarters at Carson City.

Marvin E. Fawkes, for a number of years supervising engineer at the Columbia, Mo., water, light and heating plant, has resigned.

W. P. Near, city engineer of St. Catherines, Ontario, has been appointed manager of the city's gas plant.

Steel Hunter, for eight years engineer in charge of fire protection water works at Lucknow, Ontario, has resigned to take a position in Calumet, Mich.

Lieutenant Lewis Wynne-Roberts, formerly of Regina, Saskatchewan, and a son of the well-known consulting engineer, R. O. Wynne-Roberts, has been selected for duty in Mesopotamia, and left England last March, making the voyage down the west coast of Africa and spending a few weeks in Cape Town and other cities.

The following contracting firms are building or have recently completed army camps: Fred T. Ley & Co., Springfield, Mass.; Thompson, Starett Co., New York city; Irwin & Leighton, Philadelphia, Pa.; Smith, Hauser & Macisaac, New York city; Rinehardt & Dennis, Charlottesville, Va.; Hardaway Constructing Co., Columbus, Ga.; Arthur Tufts Co., Atlanta, Ga.; A. Bentley Co., Toledo, Ohio; Mason & Hanger, Richmond, Ky.; Porter Bros., Detroit, Mich.; Bates & Rogers Construction Co., Chicago, Ill.; James Stewart & Co., New York city; Charles Weitz & Sons, Des Moines, Iowa; George A. Fuller Co., New York city; Stone & Webster Co., Boston, Mass.; Hurley Mason Co., Tacoma, Wash.; Consolidated Engineering Co., Baltimore, Md.; Fisk-Carter Construction Co., Greenville, S. C.; T. O. Brown Co., Augusta, Ga.; John O. Chisholm & Co.; Gallavan Building Co., Greenville, S. C.; W. Z. Williams, Macon, Ga.; Fred A. Jones Construction Co., Dallas, Texas; American Construction Co., Houston, Texas; J. W. Thompson Co., St. Louis, Mo.; Selden Breck Construction Co., St. Louis, Mo.; J. W. Thompson, Dallas, Texas; Algernon Blair, Montgomery, Ala.; T. S. Moody & Co., Chattanooga, Tenn.; Stewart McGhee Construction Co., Little Rock, Ark.; W. E. Hampton Co., Los Angeles, Cal., and The Lindgren Co., San Francisco, Cal.

The following officers are the construction quartermasters at the army training camps under construction or recently completed at the locations named: Captain Edward Canfield, Jr., Ayer, Mass.; Major O'Kelly Myers, Yaphank, L. I.; Harry O. Williams, Wrightstown, N. J; Major Ralph F. Proctor, Annapolis Junction Md.; Captain Edward, Petersburg, Va.; Major William Couper, Columbia, S. C.; Major James N. Pease, Atlanta, Ga.; Captain Ward Dabney, Chillicothe, Ohio; Major F. E. Lamphere, Louisville, Ky.; Major Earle B. Morden, Battle Creek, Mich.; Major D. H. Sawyer, Rockford, Ill.; Major John R. Fordyce, Little Rock, Ark.; Major M. A. Butler, Des Moines, Iowa; Captain J. F. Herman, Fort Riley, Kan.; Captain George E. Thorne, San Antonio, Texas; Captain D. L. Stone, American Lake, Wash.; Major C. H. Greene, Charlotte, N. C.; Lieutenant-Colonel J. D. Kilpatrick, Spartansburg, S. C.; Major Gratz B. Strickler, Augusta, Ga.; Major L. C. Dulin, Anniston, Ala.; Major A. G. Doyle, Greenville, S. C.; Major Walter Hernwood, Macon, Ga.; Major Hanson, Waco, Texas; Captain W. P. Roth-

rock, Houston, Texas; Major Charles H. Miller, Deming, N. M.; Major George D. Guyer, Fort Sill, Okla.; Major P. J. Van'zuben, Fort Worth, Texas; Major A. W. Reynolds, Montgomery, Ala.; Major W. J. Howard, Hattiesburg, Miss.; Major W. R. Goss, Alexandria, La.; First Lieutenant Charles Rogers, Linda Vista, Cal.

Andrew T. Hansen has been appointed city engineer of Los Angeles, to succeed Homer Hamlin. He is a graduate of the University of California and was formerly an engineer on the United States reclamation service. Since 1906 he has been in the engineering department of Los Angeles, serving as chief deputy of the city engineer since 1913.

W. H. Schwartz has been appointed city engineer of Vancouver, Wash. Formerly he was county engineer of Clark county in that state.

Professor George C. Whipple, head of the sanitary engineering department of Harvard University and a member of the engineering firm of Hazen, Whipple & Fuller of New York city, recently went to Russia as a member of the American Red Cross mission. He is well known for his writings on sanitation and for his reports and contributions to technical literature.

A. E. Berry is sanitary engineer with the Ontario provincial board of health at the Toronto experiment station. He was formerly associated with James, Louden & Hertzberg, consulting engineers of Toronto.

E. R. Gray has been appointed city engineer of Hamilton, Ontario, in charge of water works and sewage treatment plant. He was formerly deputy city engineer of the same city.

John Neeham has been appointed city engineer of Burlington, Wash.

S. G. Swigart has closed his office at Missoula, Mont., and has re-established his consulting civil engineering and hydraulical engineering practice at Akron, Ohio.

John W. Alvord, C. E., of the firm of Alvord & Burdick, consulting engineers, Chicago, has been appointed by Governor Lowden of Illinois as a member of the Illinois state board of natural resources and conservation. He is to advise on water resources. There are four other members of the board, specializing in geology, biology, chemistry and forestry, respectively. The board is appointed under the new civil administrative act and is expected to study the resources of the state, the work of its departments under the lines indicated and advise the governor and the legislature from time to time on matters in which the welfare of the state may be promoted. The members of the board serve without compensation.

George B. Post & Sons, architects, and Ernest P. Goodrich, engineer, announce that they have become associated professionally in the practice of architecture, engineering and city planning. The architects' office is at 101 Park Ave., and the engineers' office at 261 Broadway, New York city.

Calvin W. Hendrick has resigned as chief engineer of the city of Baltimore.

Coming Conventions

NATIONAL ASSOCIATION OF PURCHASING AGENTS—Annual congress at Pittsburgh, Pa., Oct. 9-11. Permanent headquarters, 600 Westinghouse Bldg., Pittsburgh.

LEAGUE OF KANSAS MUNICIPALITIES—Annual convention at Wichita, Kans., Oct. 9-11. Sec'y, C. H. Talbot, University of Kansas, Lawrence.

LEAGUE OF MINNESOTA MUNICIPALITIES—Annual convention at St. Cloud, Oct. 17-18. Sec'y, Richard R. Price, University of Minnesota, Minneapolis.

OKLAHOMA SOCIETY OF ENGINEERS—Annual convention at Oklahoma City, Oct. 29-30. Sec'y-Treas., Horace V. Hinckley, Oklahoma City.

CITY MANAGERS' ASSOCIATION—Annual meeting at Detroit, Nov. 19-24. Sec'y, W. L. Miller, City Manager, St. Augustine, Fla.

VIRGINIA GOOD ROADS ASSOCIATION—Annual convention at Richmond, Jan. 15-17, 1918. Sec'y, C. B. Scott, Richmond.

FIRST CHICAGO CEMENT MACHINERY AND BUILDING MATERIAL SHOW—Supersedes annual Chicago Cement Show. To be held under auspices of the National Exhibition Co., 123 W. Madison St., at the Coliseum, Feb. 6-13, 1918.

Obituaries

James Peter Beck

On Saturday, September 8, James P. Beck died at the Presbyterian hospital, Chicago. At the time of his death he was general manager of the Portland Cement Association, with headquarters at 111 W. Washington St., Chicago. Mr. Beck was a little past 31 years of age.

He was graduated from the University of Illinois in 1907 with the degree A. B. in L. & A. On his graduation he entered the employ of the Universal Portland Cement Company. Two years later he was made publicity manager of that company by Edward M. Hagar, then president of the Universal Portland Cement Company. A little story in connection with this promotion to so responsible a position gives an insight into the business ability of the man who was taken away while yet almost youthful. Edward M. Hagar, it will be remembered, was the father of the Cement Products Exhibition Company, and while one of the cement shows was being planned became too ill to attend to details and transferred the responsibility to Mr. Beck with the remark, "Well, see what you can do with it." What Mr. Beck did on this occasion and on the numerous others which followed while he was identified with the Cement Products Exhibition Company are too well known to need comment. His first as well as following efforts to make the Cement Products Exhibition Company a success were noteworthy. Mr. Beck was also a prime mover in the two national conferences which were held in Chicago known as the national conference on concrete road building.

During his term at college he was editor and manager of the Illio, the Junior Annual, and manager of the Illinois Magazine. He was captain and regimental adjutant of the cadet regiment at the university and was president of the Illini Club, Chicago, for one year. He was a member of a number of clubs, associations and fraternities.

During the fall of 1915 Mr. Beck was chosen to formulate plans for broadening the scope of work of the Association of American Portland Cement Manufacturers, the headquarters of which were then in Philadelphia. After several months' work, he submitted at the annual meeting of the association in December, 1915, a very comprehensive plan which was adopted essentially in its entirety. Mr. Beck was then made general manager of the association to put into effect and carry out the plan which he formulated. How successful this has been is known to every one whose interests have kept them in touch with the rapid developments of the cement industry and the work of the Portland Cement Association during the past two years.

TRADE NOTES

Andrew Langenbacher has been appointed sales manager of the Duplex Truck Company of Lansing, Mich. He was formerly in charge of exports, as well as a sales division of the Reo Motor Car Company, and has a wide acquaintance among automobile distributors in this and foreign countries. He expects to double the dealer organization of the Duplex Company at once.

Mr. Austin, chief engineer of the Gramm-Bernstein Motor Truck Company of Lima, Ohio, who was chosen from among the leading truck engineers of the United States by Captain Britton of the United States army who has charge of the laying out of the standardized army chassis, is now in Washington working every day upon the plan for this standardized army motor truck.

A large number of orders for Packard Twin Sixes of the third series have been received from the Hawaiian Islands, Cuba, China, Spain, Brazil and Argentina, despite the fact that excepting in Cuba and Brazil, even the dealers have not seen the new cars. The sales have been made on the "Packard" reputation and the descriptive literature that has been sent out. The policy of the Packard company on foreign business seems to have taken well all around.

All the property as a going business concern of the Blaw Steel Construction Company and of the Knox Pressed and Welded Steel Company, respectively, have been consolidated and merged into the Blaw-Knox Company, and all property and business of each of the former companies will hereafter be transacted by the Blaw-Knox Company, which has taken over all contracts, has acquired all current accounts and is prepared to meet all outstanding obligations of the Blaw Steel Construction Company and the Knox Pressed and Welded Steel Company, respectively, when due. All unfinished contracts of each of the former companies will be carried out and performed by the Blaw-Knox Company without interruption. All payments will be made from the office of the Blaw-Knox Company at Hoboken, Pa., and checks for accounts due the Blaw Steel Construction Company and the Knox Pressed and Welded Steel Company should be drawn to the order of the Blaw-Knox Company and mailed to Blaw-Knox Company, P. O. Box 915, Pittsburgh, Pa.

The Ransome Concrete Machinery Company of New Jersey has just been incorporated to take over the business and plants of the Ransome Concrete Machinery Company of New York. The latter company has been successfully engaged in business for over twenty-five years. Increases in business and the necessity of covering a very large export field has made necessary the bringing in of new and larger capital. The new company has a capital of $1,000,000, $500,000 in 7 per cent cumulative preferred stock and $500,000 in common stock. The new company is to be enlarged in its capacity of production so that it will cover the entire field of contractors' equipment in concrete machinery and the road builders' requirements of all kinds. Its road pavers are being used largely all over this country and its pneumatic machinery is finding use wherever large masses of concrete are wanted and rapid mix and quick delivery is a requisite. The New York and the Brooklyn subways were built with the Ransome-Canniff pneumatic mixers.

On account of the increasing demand for Texaco Asphalt in all parts of the United States, the Texas Company this year has doubled the capacity of its plant in Port Neches, Texas, making it the largest refined asphalt plant in the world, and has also built large exclusively asphalt refineries in Norfolk, Va., Providence, R. I., and Marcus Hook, Pa. Texas, of course, uses only a very small per cent of the output of these refineries, for there are many eastern cities that each lay more pavements per year than the whole state of Texas does, and all contractors who are acquainted with paving conditions outside of the state know that Texaco is a factor in every letting.

The Federal Motor Truck Company announces the election of W. C. Rowley, for some time a member of the board of directors, to vice president in charge of sales, succeeding J. F. Bowman, resigned. Mr. Rowley assumed his new duties on August 16. He has been connected, in various capacities, with the Michigan Central Railroad for thirty-two years. He began his railroad career as agent for the fast freight lines of the M. C. Ten years later he became general agent, continuing in this capacity for two years, when he was advanced to assistant general freight agent at Bay City. In 1903 Mr. Rowley became general freight agent at Detroit, from which position he resigned to take up his duties with the Federal Motor Truck Company.

Improving Road Drainage With Dynamite

There was a section of road in Chester county, Pennsylvania, which caused trouble for a long time by remaining water-soaked after heavy rains. The side ditches were laid out properly and had good outlets into neighboring brooks, but the roadbed was not drained satisfactorily by them. This roadbed was well consolidated and it was considered undesirable to dig it up to permit the installation of cross-drains in it if another remedy could be found. It was finally decided to bore holes in the bottom of one of the ditches and loosen the material in the bottom of these holes by exploding light charges of dynamite there. This is a very old practice for increasing the flow of oil and water from deep wells, and worked very satisfactorily on the road in question. The bottoms of the holes were in shale, which was so loosened by the blast that this deep-lying material was provided with a number of cisterns or chambers, into which the water in the roadbed drained freely after each rain. This remedy was provided at far less cost than the installation of cross-drains would involve and the road was kept intact.

A Roller for Finishing Concrete Roads and Pavements

Prominent highway engineers have endorsed the Macon concrete paving roller, as originated by Captain J. J. Gaillard, city engineer of Macon, Ga. Rollers of this type are being manufactured and marketed by the Ransome Concrete Machinery Company. For ease in manipulating concrete it is necessary to use a little more water in the concrete mixture than is required for the maximum strength of the concrete. With the roller method of finishing much of the excess water is removed from the concrete in the process of rolling, while at the same time the concrete is considerably compacted. The effect of the roller has been characterized as that of a rolling squeegee. It takes out the slight uneven places in the surface which may be present if a template is used in striking off the pavement surface. Rolling continues until the free water no longer comes to the surface. Tests indicate that rolled concrete is 20 per cent stronger than hand finished concrete.

The roller is equipped with a long handle and the operator stands clear of the green concrete. The roller is demountable and weighs 102 lbs. gross. The bearing weight on the road is 85 lbs. The roller is 10 ins. in diameter and 72 ins. long. The device is collapsible and easily shipped. This is one of those small adjuncts to practical road building that jumped into favor with contractors and engineers.

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Design, Construction, Operation and Maintenance of all Public Works

When Will Engineers Be Better Paid?

Of late there has been considerable discussion of the financial status of the engineer with special reference to the period of the war and the period of reconstruction which inevitably must follow the war. Many there are who hold that engineering is on the eve of becoming the most lucrative of professions. Others who have long hoped, and perhaps occasionally prayed, for better pay for the engineer, without noting any material increase in his stipend incline toward the pessimistic view that engineers will continue to receive relatively low salaries. What are the facts and what conclusion may confidently be predicated upon the facts?

Here are the facts: Heads of engineering schools all over the country are reporting that the supply of graduates is wholly inadequate to meet the demand. No over-supply of graduates is in sight and a dearth of graduates is now present and is likely to continue. Considerable numbers of engineers are being drawn into some form of military service or some work closely allied thereto. The longer the war continues the greater will be the diversion of engineers from civil to military pursuits. One consulting engineer reports that the government is taking his best men as fast as he can train them. During the construction season now drawing to a close many employers of engineers have reported difficulty in getting men. In some sections of the country 25 per cent. increases in engineers' salaries have been noted.

Now what conclusions may we draw from the facts as stated? First, the elemental economic law of supply and demand is even now operating in the engineer's favor and will continue to do so as long as the demand for engineers exceeds the supply. This condition may continue for months, perhaps years, to come. Everything considered it is more likely to be months than years. Whether this period of better days for the engineer, based on the workings of the law of supply and demand, continues for months or years it must all too soon end and then the pendulum will swing in the opposite direction. Then what? Low salaries again, probably for an indefinite period **unless** engineers embrace the plan of collective bargaining in some form.

The turning point of this discussion is that word **unless,** which is an own cousin to another innocent appearing word, namely, **if. Unless** engineers agree among themselves to demand better pay they will not get it, excepting during short periods like the present emergency; but **if** they agree to demand better pay they will certainly get it and will as certainly continue to get it for an indefinite period.

Anyone who has followed the discussion of the status of the engineer for the past twenty years must recognize the fact that the engineer's economic salvation cannot be achieved by faith and works alone. The engineer has won the admiration of the entire community with his works, and his faith that eventually he would be well rewarded for his works has done him great credit, from certain viewpoints. But he has gone on year after year, still hoping and still achieving without getting his proper money reward. Meanwhile, let it be said, he has been happy in his work and in feeling sorry for himself because he was so poorly paid. He has used enough paper in discussing his pay to cover the earth and has also exhaled enough breath in the same discussion to cool a great deal of porridge. Despite all this sort of discussion engineers have continued to draw low, discouragingly low, sometimes ridiculously low, salaries.

The inevitable conclusion of any careful study of this question is that engineers will continue to draw low salaries as long as they will work for them. Meanwhile discussion of the question is not wholly without value as men can talk themselves up to the point of making even a bayonet charge. Perhaps after some more years of discussion engineers will begin to ask themselves: "What are we going to do about it?" After some more discussion somebody will suggest that engineers must demand better pay. Again, after still further discussion, the suggestion will be adopted. Then, and not until then, will the engineer become a permanently well-paid professional man.

The 1920 Presidential Election.

The 1920 presidential election is still far away, thanks be to Allah, but its shadow even now flits across the business doorway occasionally. One or two irrepressible politicians seem unable to forget partisan politics even in the first year of what may be a long war and show symptoms of breaking out with virulent partisan attacks on the government. It would be a blessing of the first order if the politicians could be kept quiet until about July 4, 1920. There would be ample time after that to do the inevitable pointing with pride and viewing with alarm. Of course that is too much to expect but business men have a right to ask that politicians wait much longer than usual before beginning the manufacture of opinion.

Business men will do well to frown on partisan political discussions during the war. The conduct of the war and the results of the war will loom largest in the issues to be fought out at the polls at the next presidential election. This is inevitable. There will be ample time to apportion political rewards and punishment before the next big election, even if we wait until midsummer, 1920, so let all sensible men turn a deaf ear to the politicians who, if given the least encouragement, would steal our time and hurt our business with their palaver all during 1918 and 1919.

"Pork" and Waterway Development.

So savage at times have been newspaper attacks on Congress that all sorts of construction paid for by federal money have been lumped together and branded as "pork." Thus a year ago one set of newspapers called the federal aid road appropriation law a pork law. The annual River and Harbor Bill is always called pork barrel legislation by a section of the lay press. The River and Harbor Bill of 1917 was denounced as pork legislation and some citizens were known to justify their lukewarmness toward the Second Liberty Loan by the assertion that: "Congress will not give up its pork, even in war time, so why should I make sacrifices to aid the government?"

There is neither disposition nor ability to deny that some River and Harbor Bills have been well stocked with "pork." But this is not true of the 1917 bill at least. This bill carried but $27,826,150 and its passage through House and Senate was rendered difficult by the accusing cry of "pork." This cry was raised by that coterie in Congress which, for demagogic reasons, is always "against the government," and by many newspapers which should have known better and who doubtless did know better.

This charge has been refuted by the Atlantic Deeper Waterways Association in a statement entitled: "Why not Tell the Truth About the River and Harbor Bill?" The statement points out that the bill, drawn in accordance with the estimates of the Chief of Engineers of the United States Army and approved in advance by the Secretary of War and the President, is a wise and practical measure as a study of its schedules will show. The statement implies that the criticisms of the bill, which went the rounds of the newspapers, were due to the fact that editors found it more convenient, under pressure of other work, to use the same old ready-made and time-tried statements that have been used against all such bills in recent years than to analyze the bill. These statements and phrases include: "Waste and extravagance," "no practical need for the work," "millions going into little creeks," "rivers that ought to be paved," "streams that should be stood up on edge," "chunks of pork," "items tacked on for individual members," and, where sectionalism still appeals, "The most is intended for distribution in the South." The Association denied all these allegations and challenged members of Congress and representatives of the press to cite facts in support of them.

How ridiculous are the claims against the legitimacy of this bill may be seen from the fact that 51.5 per cent. of the money it provides is for the improvement and maintenance of ocean harbors, 8.1 for inland lake harbors and channels, 31.3 per cent. for five leading rivers, 1.2 per cent. for examinations, surveys and a commission, and the remaining 7.9 per cent. covers all other projects in all parts of the country.

These facts are cited here for a variety of reasons. First, they show that Congress is not wasting public funds and thus forfeiting claim on popular support of the war; second, they should indicate to everyone the unfairness and folly of catching up the cry of "pork" every time it is uttered by certain newspapers; third, they should restore public confidence in river and harbor legislation and, fourth, this should lead to the early, intelligent and extensive waterway development which is essential to the growth and prosperity of this country.

The Metric System.

Our old friend of the college classroom, the metric system, is just now receiving somewhat more attention than usual in English speaking countries. The advocates of the system are not more enthusiastic than they have been in recent years, but those who oppose the system are more outspoken in their opposition than ever before.

The present view in England is well summarized by a prominent civil engineer as follows: "We cannot change over to the metric system. Only one-quarter of mankind employ it, and half of these are our bitter enemies and unfriendly. To alter our ancient systems to suit Belgium, Serbia and Roumania is to burn the house down to secure some roast pig. Russia, our great and valuable neighbor and ally, is non-metric and already uses the foot, inch, yard and pound weight. I submit that if the Belgians, Serbians and Roumanians have a spark of gratitude for Britain and the United States of America they will accept my suggestion (to adopt the foot, inch, yard and pound weight), without hesitation or demur." This expression of opinion was brought out in connection with a discussion of the rebuilding of the portions of Belgium, Serbia and Roumania laid waste by Germany.

This view is important as it is representative of present feeling in the British Empire. With the war daily drawing the English speaking countries closer together in all things and with the British firmly opposed to a change the chances that America will adopt the metric system are extremely remote.

Solving Engineering Problems by Popular Vote.

Occasionally a city settles its engineering problems by a vote of the people. An extreme example of this particular kind of folly occurred in a West Virginia city a few years ago when the city called an election at which the people voted their choice between two contending systems of water purification. The experts disagreed so the utterly inexpert plain people were called on to decide by their votes.

Recently, property owners in an Oklahoma city decided on the type of pavement to be constructed. The proceedings were delightfully informal. The members of the city council and the property owners assembled in the court room. Standing room was at a premium. The mayor presided and announced as the object of the meeting the making of a choice of paving materials.

Each sales engineer, representing a paving company, was allowed fifteen minutes in which to explain the merits of his product. Five men spoke for a total of one hour and fifteen minutes and the assembled freeholders took it all in "profound as prairie dogs." Then they voted and the cheapest pavement, cheapest in first cost, was an easy winner.

Ninety-nine times out of one hundred the people, if given a chance, will vote for the thing that costs least to start with. This is only natural and might be expected for the first cost is the only thing that means anything to the voters. Since the thing that is cheapest to begin with is not always cheapest in the long run the folly of letting the people vote on such matters is evident. The principle, moreover, is absolutely wrong, as such questions are highly technical and should be decided by trained experts, acting for the people who are incompetent to decide for themselves.

Solving the Water Supply and Sewerage Problems at the Camp Pike Cantonment

By E. B. Black, of Black & Veatch, Consulting Engineers, Interstate Building, Kansas City, Mo.

Camp Pike, the cantonment for the Twelfth Division of the National Army, is located on a 3,000-acre tract of rolling and heavily wooded land, about 5 miles north and west of Little Rock, Ark. The buildings on the camp site are permanent wooden buildings, to accommodate 43,000 men. On the camp site is also a base hospital of 1,000-bed capacity.

Electric Power

Electric light and power is purchased from the Little Rock Electric and Railway Company and is transmitted to Camp Pike over a 3-phase, 60-cycle, 13,200-volt line to a transformer station on the cantonment site, where it is stepped down to 2,300 volts.

Arkansas River valley, in or near Argenta, 5 miles from the cantonment. Such wells would furnish a sufficient supply, but contained from 2 to 16 parts of iron, and in some cases showed manganese.

The Arkansaw Water Company supply is drawn from the Arkansas river, and at times when the river water has a high chlorine (Na Cl) content, well water is mixed with it for the purpose of dilution. The mixed water is then filtered and treated with liquid chlorine before going to the consumer.

The government entered into contract with the Arkansaw Water Company for a supply, and built the pipe line from the city of Little Rock to the cantonment. Water is delivered at

VIEWS ON CONSTRUCTION OF CAMP PIKE CANTONMENT. FIG. 1—PUMP HOUSE WITH PUMP INSTALLED AND WALLS BEING BUILT. FIG. 2—AIR COMPRESSOR PLANT AND ELECTRIC LIGHT AND POWER LINES ON 23-FOOT SEWER CUT. FIG. 3—SEPTIC TANK READY FOR ROOF. FIG. 4—NATIVE STONE ARCH FOR CARRYING SEWER ACROSS RAVINE.

The electric construction involved no special problems excepting that it was necessary to secure about 4,000 kilowatt capacity in transformers, from 100 to 700-k.w. units, between July 7 and September 1. The transformers were ordered, built, delivered and erected on time.

The Water Problem

The water problem was difficult, in that a sufficient supply from wells or impounding reservoirs on the camp site was impossible. A temporary supply for construction purposes was obtained by tank trucks from Argenta, 5 miles away, and from four wells on the camp site, ranging from 60 to 100 ft. in depth.

Preliminary surveys showed two possible sources for the permanent supply of from 2,250,000 to 2,500,000 gallons per day: (a) To purchase water from the Arkansaw Water Company, of Little Rock, or (b) to develop wells located in the

the Little Rock end of the free bridge across the Arkansas river at about 60 lbs. pressure. It is conveyed by a 12-in. wrought-iron pipe line 1,700 ft. long, across the bridge, and by a 16-in. cast-iron line 1,300 ft. long to a meter station owned by the water company. Here it enters a 16-in. pipe line of California redwood and is delivered to a 100,000-gal. redwood tank at a booster station about midway between the city and camp. The booster station has three belt-driven Platt Iron Works centrifugal pumps, each with a capacity of 750 gal. per minute, against a 300-ft. head. These pumps are driven by 3-phase, 60-cycle, 2,300-volt, 100-h.p. motors.

The force main between the booster station is also 16-in. California redwood, and delivers the water to five 100,000-gal. redwood tanks on the cantonment site.

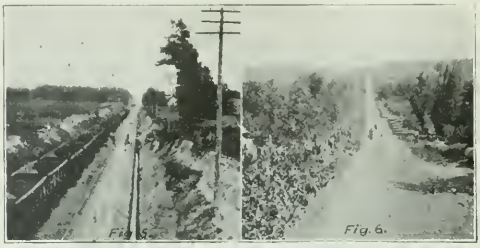
From these five tanks the water is distributed about the camp by direct pressure through four Allis-Chalmers direct

connected motor-driven pumps, two of 1,000 and two of 1,200-gal. per minute capacity.

The distribution system about the camp consists of 12, 10, 8 and 6-in. cast-iron and wood pipe, with a total of approximately 290 two-way fire hydrants. The storage tanks and direct pumping station are located about the center of the tract (1 mile by 2 miles) occupied by the camp, and part of the camp can be supplied by gravity from the tanks. These tanks are 16 ft. deep and 48 ft. in diameter, set on concrete piers, high enough to bring them to equal elevations above the ground surface, with a minimum ground clearance of 12 in. Two of the temporary wells are being fitted with deep well pumps and motors for use in cases of emergency.

The Sewer Problem

The sewer problem at Camp Pike was difficult, due to the fact that the south half of the camp drained to the Arkansas river above the city of Little Rock and the other half to the same river some 60 miles below Little Rock.



FIGS. 5 AND 6—SIXTEEN-INCH REDWOOD FORCE MAIN CONSTRUCTION BELOW AND ABOVE BOOSTER STATION.

It was necessary to take the sewage from the south half of the camp through the divide by means of a short cut 23 ft. deep. The average depth of trench for the entire sewer system was about 4.5 ft., and approximately one-half the excavations on trunk sewer lines was in rock ranging from trap to sandstone.

Trenching machines were used with some degree of success on part of the mains and laterals, but for the most part hand work was necessary.

Steam and electric compressor stations were set up along the line of work and moved to new locations as a given section of the trench was finished. On part of the trunk lines electric lines were erected and much of the drilling and pipelaying was carried on day and night.

A portable lighting plant consisting of a Delco engine and batteries, mounted on a wagon, was used to good advantage for night work on both water and sewer lines.

The original plan included a septic tank for sewage disposal, but as the effluent from the plant has to be emptied into a dry ravine, sprinkling filters were authorized later and are now being built.

The original plan of about 25 miles of sewers and septic tank, about 30 miles of water lines and two pumping stations, were designed by the engineers and built by the contractors in 60 days, under the engineers' direction.

The high record for sewer pipe laying in a single day was 5,900 ft. of all sizes of pipe.

Personnel

The construction of the camp was under the direct charge of John R. Fordyce, Major Engineers, U. S. R., constructing quartermaster, with Black & Veatch, consulting engineers, in full charge of the design and supervision of construction of sewers, sewage disposal, water supply and pipe lines, and electric light and power. James Stewart & Co. were the general contractors.

The Relations of the Engineer to the Contractor

By S. M. Swaab, Philadelphia, Pa.

In every instance the contractor should receive a square deal at the hands of the engineer and in no instance should the engineer have it in his mind to get square with the contractor for some fancied or even real act of omission or commission. Those who have had sufficiently broad experience recognize that specifications are intended to be interpreted in the spirit, rather than in the letter. As Theodore Cooper, in his day recognized as the foremost bridge engineer in this country, put it, "The best system of rules to insure success must be interpreted on the broad grounds of professional intelligence and common sense."

Relations Should Be Cordial

Constant bickering, indicating lack of poise and persistent petty fault-finding without being able to offer suggestions for the betterment of conditions, is the method pursued by many young engineers to the detriment of the work on which they are engaged.

There is absolutely no reason why the most cordial relations should not exist between the contractors and engineers engaged on the same work and there are probably the very best of reasons why they should, as their interests are alike, said Mr. Swaab in addressing the Engineers' Club of Philadelphia.

The specifications are often the rock on which the cordial relations of the engineer and the contractor are rent asunder.

Contractors, like engineers, are actuated by the same motives as other men. The engineer may or may not be superior to the contractor, but he cannot show his superiority by taking undue advantage of him.

Much Grief in Contracting

Contracting, according to the usual methods in vogue, of which some one has aptly said, "The profits are limited by competition, but the losses may be unlimited," should no longer prevail, but as it is or should be a legitimate business, the gambling element should be removed therefrom, and should certainly not exist to a greater extent than it exists in any other ordinary business.

Contractors would be better men as well as better contractors if their remunerations were fixed, rather than problematical as is usual.

The party for whom the work is being done should take all of the incumbent risks, and then any incentive of the contractor to take advantage is removed.

Misusing Specifications

Some specifications deliberately give the engineer the whip-hand, but it has been determined in the courts of this country that it cannot be employed without considerable danger. As engineers we know that the action and reaction are equal.

Clauses which have a double meaning or which can be interpreted in two ways should not be written in specifications. A contract represents a meeting of the minds of the contracting parties. The engineer should not attempt to protect himself by inserting obscure clauses in specifications whereby he may cover up his own ignorance or shortcomings at the expense of the contractor.

Copying clauses from one specification into another without fully understanding their meaning, simply because they are time honored, i. e., because custom has sanctioned them, which is not unusual, is a very silly and at the same time dangerous practice.

Few men have ever been vested with considerable power who haven't at times abused it, and the engineer who prepares the specifications and who interprets them and who in the case of dispute has the last say, in fact is the "sole arbiter," has to be a bigger man than the ordinary to be absolutely unbiased. In the case in question the engineer is judge, jury and

prosecuting attorney, all welded into one, and the one who usually suffers, and to whom is meted out the punishment, unless the engineer happens to be a very big man, is the contractor.

Speedy Construction Methods in Increasing Seating Capacity at White Sox Ball Park

The American League ball park in Chicago, more familiarly known as the "Sox park," covering a ground area of approximately 14 acres and having a regular seating capacity of about 29,000, has been widely heralded as the largest ball park in the world. In preparation for the recent world's series games, besides the construction of 3,000 temporary seats, it was decided to increase the permanent seating capacity by building 1,000 additional box seats around the front of the first floor of the grand stand. This made the permanent seating capacity 30,000 and the temporary capacity approximately 33,000.

VIEW SHOWING LAYOUT OF CONCRETING PLANT USED IN ENLARGING SEATING CAPACITY OF WHITE SOX BALL PARK BEFORE WORLD'S SERIES.

Rapid construction was required, as the entire work had to be completed in eleven working days. The work consisted in building four rows of box seats around the entire front of the grand stand 578 ft. in length, the construction of two new shelter houses, each 30 ft. long by 6 ft. wide, with walls 8 ft. deep, and a new front foundation footing 3 ft. deep, surmounted by a solid reinforced concrete rail 3½ ft. high along the entire front of the grand stand. A base for the concrete work was made back of the front footing by filling with cinders. All metal piping separating the boxes was set into the concrete and concreting was done in alternate sections to provide for contraction and expansion.

The general contract for this work was let to Standard Concrete Construction Company, 108 South LaSalle street, Chicago, who used for mixing the concrete two 1-3 yd. "the Standard" low charging mixers. Material was delivered in wagons and motor trucks and distributed along the front of the stand, leaving only enough room to set the mixers between the supply piles and the front footing. The portability of the mixers enabled them to be easily moved along, as the work advanced so that the entire operation of delivering aggregates to the mixers and the mixed concrete to the forms was accomplished by hand-wheeling the shortest possible distances.

The accompanying view shows the work in progress and illustrates how the mixers were kept close to the locations where the concrete was being placed so that manual labor was reduced to the minimum. A considerable quantity of sectional forms was required for the long front concrete rail and the shelter houses, but by moving the mixers along first to put in the footings and then to put in the floor slabs and front rail the work proceeded so rapidly that it was easily completed within the specified time limit.

Well Water Development on State Land in New Mexico

An interesting example of what water development will accomplish in the general development and material advancement of a community is found on lands owned by the state of New Mexico in Torrance county, as reported by James A. French, state engineer. These lands are leased for grazing purposes by Captain Charles L. Ballard and are known as the Ballard lease. This lease comprises 86,000 acres, and prior to an exploration for water carried out by the state engineer's department, the land was found practically valueless. The rainfall was not sufficient for farming without irrigation, and there was no surface water either for irrigation or livestock. The lessee had expended considerable amounts in drilling for water for his stock and sunk three wells to an average depth of 500 ft. without success. Thus the land was useless to the lessee and its value to the state was low. After an investigation the engineering department concluded that water would be encountered at greater depths and three test wells were sunk, under the provisions of the special appropriation for that purpose. These wells vary in depth from 700 to 1,250 ft., and in each one a flow of good water was developed, ranging from 10 to 20 gals. per minute.

With this water supply available the state land department has been able to perfect a very satisfactory lease from the standpoint of the state and to develop a revenue from land which promised theretofore to remain idle on the state's hands. The lessee is now grazing approximately 3,000 head of cattle on the land and has range capacity for approximately 6,000 sheep. The lessee has equipped these wells with both gasoline engines and windmills and has demonstrated that windmills may be used successfully for raising water from great depths. The net result of the drilling of these test wells has been to increase the grazing area of the state by the acreage of this lease, and to add very materially to the value of the land.

Convicts on Road Work

The use of convict labor on road work has met with considerable success in New York State, according to a report covering the year 1916, when three gangs from the State Prison were employed. Second Deputy Highway Commissioner Fred W. Sarr says in his report: "The use of convicts on the highway work resulted in a considerable saving to the state in both the highway department and the prison department, and it is recommended that the practice be continued, at least as long as the present stringency in the labor market continues."

In cases where the nearness of the road work to the prison permitted it, the men were taken back to the prison daily, but where the work had to be carried on at a considerable distance houses were constructed or rented at the job.

What Cities Levy Wheel Tax or License

The Editor of Municipal Engineering:

Sir—Will you be good enough to send me the names of any cities which have adopted a wheel tax? We should also like to have a copy of any ordinance on this subject.

C., Albany, N. Y.

This inquiry is referred to our readers. If the entire ordinance in any case cannot be sent, kindly send an abstract of its provisions.

Pavement Design and Construction

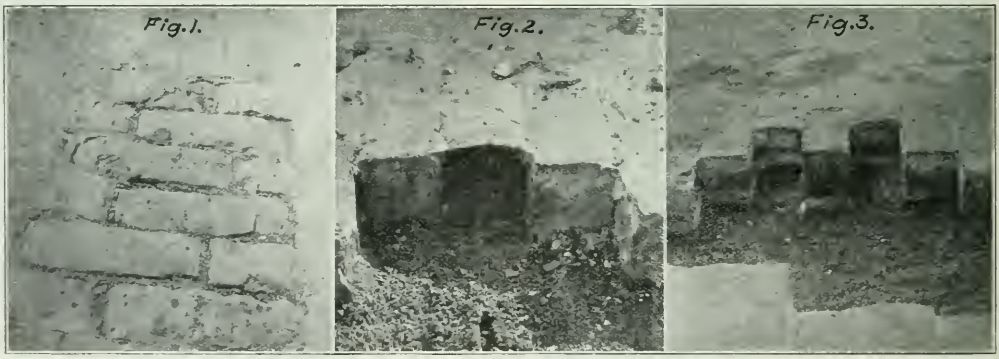
Concentration of Expansion Stresses Due to Imperfect Grouting the Cause of Brick Pavement Failures

By C. C. Wiley, Instructor in Highway Engineering, University of Illinois, Urbana.

Not infrequently defects develop in grouted brick pavements which are attributed to a failure of the foundation, shifting or shrinking of the sand cushion, or to poor brick when in reality they can be traced directly to imperfect grouting. Numerous things may cause defective grouting and thus be the ultimate source of failure, but a careful study of the failed areas will often indicate the underlying cause, the mode of failure, and means of preventing a repetition of the same mistake.

A Specific Example

The accompanying views show an interesting type of such failure. This particular spot is one of several which developed in a state aid road near Champaign, Illinois. This road is of the sand cushion type, 10 ft. in width, and was built in the fall of 1914 under the supervision of the State Highway Department. In general it is an excellent piece of work both in materials and workmanship. During the summer of 1916, however, several small "pot holes" came into evidence and with the view of ascertaining the cause of these isolated defects the writer secured permission to open some of them.



VIEWS SHOWING FAILURE OF BRICK PAVEMENT DUE TO IMPERFECT GROUTING. FIG. 1—DEFECTIVE SPOT BEFORE OPENING. FIGS. 2 AND 3—VIEWS FROM OPPOSITE SIDES OF OPENING.

Fig. 1 shows the defective spot before opening the pavement. The filler was shattered and the edges of the brick spalled off and rounded, while the adjacent surface was in perfect condition. Figs. 2 and 3 are views from opposite sides of the opening and show clearly the conditions which existed in the pavement at that point.

The sand cushion was firm and well compacted and did not extend up into the spaces between the brick. At the bottom of the joints was a layer of grout about half an inch thick at the middle of the hole, but gradually increasing in thickness towards the sides until the joints were entirely filled. On top of this was a thin layer of clay and laitance. At the top the joints were well filled to a depth of about an inch only, thus leaving the middle part of the joint entirely vacant. As already noted, the brick were badly spalled on top and in addition, one brick, as shown by Fig. 3, was badly shattered at the bottom and one or two others showed some signs of similar failure.

Normally the pressure set up by the tendency to expand is distributed over the entire face of the brick and causes no troublesome stresses. But with such a condition as here shown existing in the slab the pressure is concentrated at the edges of the brick and results in stresses which tend to spall off wedge shaped flakes from the brick. Possibly the brick may be strong enough to resist this pressure alone, but the failure occurs when it is combined with the weight, impact, and vibration of traffic.

Doubtless this defect was caused by over-running with the second application of grout. The first application was made with a thin grout which feathered out between movements of the grout boxes and was not brought up to level. The second application was made with a stiffer grout which appeared to fill the joints, but which in reality bridged over them and left the middle portion unfilled. Had the first application filled the joints practically full, this failure would not have occurred.

Disadvantages of Sand Cushion

One of the most prolific sources of trouble of this kind is the sand cushion which from various causes works up into the joints and prevents the grout from entering. For example, on a certain city street the writer found the entire surface of the pavement for a distance of about two blocks in the same condition as the spot shown in Fig. 1, while the remainder of the street was in excellent condition. Residents stated that at times in warm weather the chips could be swept up in quantities and they laid the blame to poor brick. Several openings were made in the pavement and in every instance in the affected area it was found that the sand cushion had worked between the bricks more than half the depth of the joints, while in the unaffected area the joints were completely filled with grout. Here again, the narrow belt of hard filler had concentrated the stresses of expansion at the edge of the brick and under the blows and vibration of traffic the brick had spalled and the filler shattered, making a rough, uneven and unsatisfactory surface.

Unfortunately no information was available as to the conditions under which these two blocks were laid except that the contractors' foreman stated that they often laid a block or two of brick ahead of the rolling and grouting. It is quite probable that this is what occurred on these two blocks and between the laying and grouting occurred a shower of rain which, with the kind of sand used in the cushion, would cause it to work up between the brick. The remainder of the street not receiving the shower in the same stage of construction was unaffected.

Perfect grouting is absolutely essential to the success of a grout-filled pavement and fortunately perfect grouting is not difficult to secure with a well designed pavement, suitable materials and proper handling.

The Cost of Surveying Roads in Illinois

The fear that engineering services would run into large sums of money has prevented many highway boards from employing engineers at the outset of road work. It is particularly desirable for engineers to be engaged before any work is definitely determined, because in many cases it is impossible for them to rectify errors of judgment made in laying out improvements by boards before the help of specialists was sought. Since 1913 the State Highway Department of Illinois has made over 400 preliminary surveys of roads under conditions which made the cost rather high. The roads were generally short sections and entirely disconnected, so that the cost of taking men to and from these sections was large in proportion to the amount of work done. The purpose of the survey in each case was to locate a center line for the proposed road, to locate all the features of the country affecting the proper position of the road, to take cross-sections of the ground along the route, and to obtain all information concerning draining and grade conditions. Some of the surveys were made in prairie land and some in rough country. Nearly 1,100 miles of road were surveyed in all at an average cost of $26.40. per mile. The average rate of survey was 0.84 mile per day, and the average length of each survey was 2.66 miles. As a rule, the work was done by two engineers paid $4 a day, three helpers at $2.50, a team at $3, and incidentals for transportation, board, lodging and supplies bringing the total cost the work would be for only a few miles surveyed by a private engineer, for no allowance is made for office expenses and profit. The figures are a good indication, however, of the small cost of the preliminary engineering work which should always be done before road improvements are started. The proper location of a road will not only give better drainage and easier grades, but will result in a considerable reduction in the cost of construction, because an engineer is able to locate a line in such a way that the amounts of excavation and embankment are reduced to a minimum consistent with a satisfactory highway.

Combining Brick or Granite Block with Wood Paving Blocks

The view herewith shows the novel combination of brick and creosoted wood paving block laid in alternate rows in the tracks of the Toledo Railways and Light Company, on Main street, Toledo, Ohio. This construction is attracting the attention of street railway engineers in all parts of the country.

On this work a 6-in. 100-lb. steel rail was used. A 2-in. header block was laid under the ball of the rail, providing for the tread of the flange of the wheels. A detail of the construction is as follows:

Alternate rows of Kreolite end lug wood paving blocks, and ordinary, second-hand paving bricks were used, with the wood blocks laid about ⅛ in. higher than the adjoining rows of bricks. The blocks were treated with but 6 lbs. of creosote per cubic foot of timber by the Rueping process, as it is only desirable to prevent the decay of the wood. Owing to the presence of the lugs the creosoted wood block will expand without buckling, keeping the construction permanently smooth, tight and compact. The interstices between the individual units comprising this pavement were filled with a Kreolite bituminous filler. The bricks used had already seen five years of service in the track and quite a number were shattered and broken.

This very interesting piece of track work has now been completed about six months, and the traffic has ironed it into smooth, compact, homogenous-appearing wearing surface.

ALTERNATE ROWS OF WOOD AND BRICK IN TRACKS OF TOLEDO RAILWAYS & LIGHT CO., TOLEDO, OHIO.

This method of construction, it is claimed, not only gives a greater stability to street car track pavement, but also prevents loose joints and loose rails, as the wood will continually swell, due to the absorption of moisture, through direct contact or through the humidity of the atmosphere, and thus keep the pavement solid and tight at all seasons of the year.

The wood block rows are laid a little higher than the rows of brick, so that the annealing effects of the traffic will weld the wood over the edges, preventing the cobbling of the bricks. The traffic on Main street has already proven that this advantage is well founded.

It is obvious that, in the case of alternate rows of bricks and Kreolite end lug wood blocks, the first cost of a creosoted wood block street pavement would be greatly reduced. At the same time many of the advantages of both kinds of paving material would be retained with none of their objectionable features, it is claimed. A brick pavement constructed with alternate rows of wood blocks would be transformed into a quiet pavement, while an ordinary rectangular creosoted wood block pavement would be transformed into a non-slippery, non-bleeding, non-bulging and much lower priced pavement.

The success of this type of construction in the tracks of the Toledo Railways and Light Company on Main street, Toledo, Ohio, to date promises a satisfactory solution of that long-sought permanence in paving between car tracks.

Using Labor-Saving Machinery on Road Construction in Vermilion County, Illinois

The contractors for road work in Vermilion county, Illinois, believe that mechanical equipment which saves them labor is well worth using. The cars which deliver stone to all but one of these contractors are unloaded by some mechanical device, such as belt conveyors or a clam-shell bucket used with a crane or derrick. The materials thus unloaded are hauled away on narrow-guage railways by seven of the nine

contractors. In order that there may be no delay in filling the cars on these railways or the wagons used by the contractors who do not employ railways, the materials taken from the cars are raised to elevated bins, whence they can be allowed to run down a chute into the cars or wagons. A contractor using such equipment after trying to get along with the old-fashioned hand labor method said that while the cost of handling the stone in this way was somewhat higher than by hand, he saved so much money in keeping all parts of the work moving smoothly without delays, and was so relieved from difficulties in securing enough competent labor at the unloading points that he was more than satisfied with mechanical equipment.

Conserving the City's and County's Assets by Utilizing Old Pavements as Foundations for New Surfaces

Macadam roadways in times past were a source of pride and the principles embodied in the waterbound macadam were successfully employed by many prominent engineers of the country under the conditions then existing. The macadam made a good road, although dusty at certain periods of the year, and was easy on horses' hoofs and a comfortable road to ride on.

But later, accentuated by the rapidly increasing automobile traffic, came the depressions with their accompanying jounces which set in motion the thinking apparati of many who had to travel over the thoroughfare in the pursuit of their daily livelihood, and for years engineers tried many processes to find something which would durably fill these depressions and give a passable road surface.

Repairing Old Macadam Roads

Some tried broken stone of crusher run with a sprinkle of bitumen which had very limited lasting quality. Many other methods of low first cost were tried, but none was entirely satisfactory to either the engineer in charge or to users of the road, to say nothing of the feeling of the city and town officials who had to keep feeding the road department with financial fuel to cover the constant expenditures of keeping the roads in passable condition.

There are two essentials to all good roads, no matter where built or for what purpose used, and these are: First, proper drainage, and, second, a suitable foundation. Owing to the lack of funds there are today thousands of miles of macadam roads sadly in need of resurfacing. It is a recognized fact that a macadam road will not stand up under the present modern traffic conditions. It is evidently the part of wisdom to recognize this fact, as do more and more the road officials who are insisting upon the adoption of proper drainage and utilizing as far as possible the present macadam, upon which vast amounts have been expended, as a foundation for a superior type of wearing surface.

COMMONWEALTH AVENUE, BOSTON, MASS. SOUTH SIDE—SHOWING MACADAM BEFORE PAVING WITH BITULITHIC.

LAYING BITULITHIC PAVEMENT ON OLD MACADAM FOUNDATION, SOUTH SIDE COMMONWEALTH AVENUE, BOSTON, MASS., 1916.

TABLE I—RESURFACING OLD MACADAM.

City.	Character Work.	Character Pavement	Sq. Yds.
Dubuque, Iowa	Resurface old macadam	Bitulithic	8,245
Asbury Park, N. J.	Resurface old macadam	Warrenite	11,988
Bergen & Hudson Counties, N. J.	Resurface new macadam	Warrenite	5,988
Essex Co., N. J.	Resurface old macadam	Warrenite	49,089
Middlesex Co., N. J.	Resurface old macadam	Warrenite	31,947
S. Orange, N. J.	Surfacing new macadam	Warrenite	1,160
Dallas, Tex.	Resurfacing old macadam	Bitulithic	76,684
Bridgeport, Conn.	Resurfacing old macadam	Warrenite	654,296
Brookline, Mass.	Resurfacing old macadam	Bitulithic	1,234
Dedham, Mass.	Resurfacing old macadam	Bitulithic	3,500
Fall River, Mass.	Resurfacing old macadam	Bitulithic	3,400
Franklin, N. H.	Resurfacing old macadam	Bitulithic	3,314
Winchester, Conn.	Resurfacing old macadam	Warrenite	9,151
Yonkers, N. Y.	Resurfacing old macadam	Bitulithic	18,636
Columbia Co., Ore.	Resurfacing old macadam	Bitulithic	18,921
Delta Co., Mich.	Resurfacing old macadam	Bitulithic	6,500
Escanaba, Mich.	Resurfacing old macadam	Bitulithic	18,000
Gilbert, Minn.	Resurfacing old macadam	Warrenite	15,733
Wallace, Idaho.	Resurfacing old macadam	Bitulithic	2,000
Yakima Co., Wash.	Resurfacing old macadam	Bitulithic	30,257
Total Yardage			988,033

TABLE II—RESURFACING OLD CONCRETE AND BITULITHIC ON ASPHALTIC CONCRETE BASE.

City.	Character Work.	Character Pavement	Sq. Yds.
Islip, L. I., N. Y.	Resurface old concrete	Warrenite	3,000
Clatsop Co., Ore.	Bitulithic on Asphaltic Concrete Base	Bitulithic	21,120
Portland, Ore.	Bitulithic on Asphaltic Concrete Base	Bitulithic	13,287
Walla Walla, Wash.	Bitulithic on Asphaltic Concrete Base	Bitulithic	14,904
Yellowstone Co., Mt.	Bitulithic on Asphaltic Concrete Base	Bitulithic	2,200
Idaho Falls, Idaho.	Bitulithic on Asphaltic Concrete Base	Bitulithic	15,491
Total yardage			57,022

TABLE III—RESURFACING OLD BRICK.

City.	Character Work.	Pavement	Sq. Yds.
Kansas City, Kas.	Resurface old brick	Character Bitulithic	8,990
Davenport, Ia.	Resurface old brick	Bitulithic	3,460
Portland, Ore.	Resurface old brick	Bitulithic	3,040
Utica, N. Y.	Resurface old brick	Bitulithic	1,130
Total yardage			16,620

Putting Bituminous Surface on Old Macadam

At first those who advocated the use of the existing macadam as a foundation for a bituminous surface were laughed at or told it could not be done. After careful investigation of a macadam road upon which paving was being contemplated the officials advocated a concrete base, but it was found that, by scarifying the road, adding a small amount of crushed stone

PLEASANT STREET, NEW BEDFORD, MASS., SHOWING OLD MACADAM BEFORE PAVING WITH BITULITHIC.

where necessary to bring the road to a proper contour and depth, and rolling it to grade, bitulithic street surface could be laid directly upon the old macadam, thus saving the city the cost of removing the old macadam, as well as the cost of new concrete foundation. This method has been tried out in many cities and counties, and they have found that bitulithic for city streets and warrenite for country roads were especially adapted for surfacing not only macadam but for resurfacing old brick or asphaltic concrete pavements which have deteriorated beyond economic use as a road surface, but available as a high class foundation for a new stable bituminous surface. This has been tried out in many places with conspicuous success; illustrations of some of this class of work are given herein.

RELAYING OLD BRICK ON THEIR SIDES, 1914. COMPLETED BITULITHIC SURFACE ROSE STREET, NEW ROCHELLE, IND.

Lists of cities and areas of contracts which have been awarded for resurfacing city streets and country roads with bitulithic or warrenite since Jan. 1st, 1917, is given herewith in Tables I, II and III.

In the light of the advance in prices of labor and material, with naturally corresponding increase in contract prices for pavement and other construction during the last two years, it is interesting to note the effect of this period on the area of

PLEASANT STREET, NEW BEDFORD, MASS., AFTER PAVING. BITULITHIC SURFACE LAID OVER OLD MACADAM.

bitulithic and warrenite surfaces. Notwithstanding the advance in cost the increase of business of the nine months of the year of 1917 has been greater proportionally than during any previous year. The 1917 contracts for bitulithic and warrenite, aggregating 8,964,551 sq. yds. (including all kinds of base), is an increase of one-third over similar contracts during a corresponding period of any previous year.

BITULITHIC PAVEMENT RESURFACED OVER OLD BRICK PAVEMENT, 1914. ROSE STREET, NEW ROCHELLE, N. Y.

This large increase has been a distinct recognition of the value of these constructions, especially in the resurfacing of macadam and other old pavements. It has been proven that the motor vehicle traffic must have a pavement surface which consists of a dense mixture which will not ravel under the suction of fast-moving rubber-tired wheels, a condition realized in the bithulithic city street pavement and the warrenite country road surface.

Items to Be Considered in Selecting Pavements in Toledo

The city of Toledo, Ohio, is in the midst of plans for the most extensive group of paving and repaving jobs ever undertaken there at one time. Many sections of the city are affected by the proposed improvements, and several thousand residents are directly interested in the work.

It is especially important, therefore, at this time, that careful consideration be given to the kind of pavement best adapted for each particular street and the standards that should be used in making the selection of materials. H. C. McClure, commissioner of engineering and construction, recently issued a statement to the citizens calculated to enable them to choose paving materials wisely.

The average citizen who is interested enough to attend a public hearing on the subject of a particular pavement has acquired some idea of the kind of pavement he would like to have laid, but rarely is his notion based on a definite knowledge of the qualifications that pavement should have. Frequently the only factor he wishes to consider is the cost. He wishes a material selected that will entail the smallest possible initial expense. Many times, on the other hand, this factor is made subordinate to durability, or perhaps maintenance cost.

But it is extremely rare that a property owner has taken into consideration all the factors that are necessary in pavement selection. For that reason Table I was prepared by Mr. McClure, suggesting the qualities that should govern the selection of pavements and their relative order of importance for various classes of districts.

TABLE I—SUGGESTED LIST OF ITEMS TO BE CONSIDERED IN THE SELECTION OF PAVEMENTS FOR TOLEDO, AND THE RELATIVE ORDER OF IMPORTANCE OF EACH FOR VARIOUS CLASSES OF DISTRICTS.

Order of Importance.	Office Building and Retail Stores District.	Wholesale Ware house and Dock or Railroad District.	Boulevards and Expensive Residential District.	Medium and Cheaper Residential Districts.	Thru Traffic Thorofares All Districts.
1.	Noiselessness.	Durability.	Appearance.	Appearance.	Durability.
2.	Appearance.	Tractive Resistance.	Durability.	Cost.	Tractive Resistance.
3.	Sanitariness.	Ease of Maintenance.	Sanitariness.	Durability.	Slipperiness.
4.	Durability.	Slipperiness.	Ease of Cleaning.	Sanitariness.	Appearance.
5.	Ease of Maintenance.	Sanitariness.	Noiselessness.	Ease of Maintenance.	Ease of Maintenance.
6.	Ease of Cleaning.	Appearance.	Slipperiness.	Ease of Cleaning.	Noiselessness.
7.	Slipperiness.	Ease of Cleaning.	Tractive Resistance.	Noiselessness.	Cost.
8.	Tractive Resistance.	Noiselessness.	Cost.	Slipperiness.	Sanitariness.
9.	Cost.	Cost.	Ease of Maintenance.	Tractive Resistance.	Ease of Cleaning.

Pavement Cleaning and Maintenance

Cost of Highway Maintenance Work in Maryland

By H. G. Shirley, Chief Engineer, Maryland State Roads Commission, Baltimore, Maryland

The State Roads Commission of Maryland consists of three members appointed by the governor to hold office at his pleasure. The chairman devotes his entire time to the work and the other two commissioners are subject to his call. The state contains about 17,000 miles of road, from which there has been selected a state system, consisting of about 10 per cent., and it is estimated that from 75 to 80 per cent. of the traffic in the state is carried by the 10 per cent. selected. Practically all of this 10 per cent. has been completed, and there is a continuous connected highway starting at the Pennsylvania line on the west through the entire state to Ocean City on the east. There have been completed about 1,500 miles of state and state-aid roads in the state, outside of the roads the counties have built on their own initiative. These 1,500 miles of roads connect every county seat with the others and with Baltimore city. Types of construction vary with the local conditions and availability of materials. Quite a large amount of concrete, bituminous materials on a concrete base are now being used. The work is done under the supervision of the chief engineer, and under him there are seven resident engineers who occupy seven residencies, which comprise the whole state. These men are located at the most convenient points in their residencies, and have charge of all construction and maintenance therein. The patrolman system of maintenance is used, and very satisfactory results have been secured.

Up to the present time there has been expended $24,000,000, including about $6,000,000 in Baltimore city for paving north-south and east-west routes, and erecting a large bridge across the harbor. A close study of traffic is made, and the wear on the surface of roads is determined as carefully as possible. It is estimated that a certain amount of traffic will wear off a given amount of surface, and it is the object of the commission to replace just a little more surface than wears off each year. Everything is estimated on the per ton per mile basis, and we find that the average cost of maintenance throughout the state is $.004 per ton per mile. We find the highest cost of maintenance in the thinly settled sections of the state, where it runs as high as $.008 per ton per mile, whereas on

some of the roads near Baltimore city, where the traffic is 2,500 tons per mile per day, the cost runs $.002 per ton per mile.

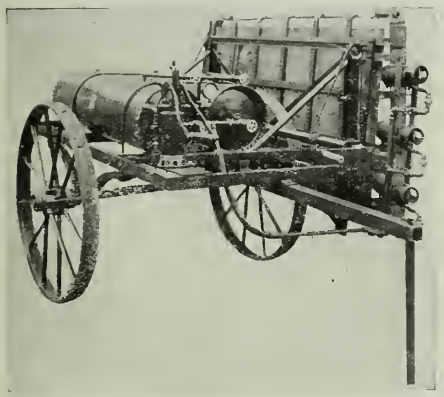
Improved Methods of Resurfacing and Patching Asphalt Streets in Detroit

By A. C. Proctor, Asphalt Expert, Department of Public Works, Detroit, Mich.

In spite of our heavy automobile traffic we have had a surprisingly small amount of asphalt street repairing to do, even on asphalt streets which have been down for as long as 30 years.

Effects of Motor Vehicle Traffic

Our oldest streets were not intended to bear their present heavy and continuously steady automobile and motor truck traffic. At the time they were laid we knew nothing concerning present conditions. Since that time, however, Detroit has grown into the largest automobile center in the world. Not only have we the greatest manufacturing production of cars and trucks, but our streets carry the heaviest traffic in this line.



TRACK SURFACE HEATER DESIGNED TO OPERATE CLOSE TO STREET CAR TRACKS WITHOUT INTERFERING WITH TRAFFIC.

New regulations affecting parking of cars and "safety spots" for people waiting for street cars have diverted this tremendous traffic into such narrow confines at this junction that all automobile and trucks travel in the same track. The constant grind and tear of tires, instead of being more or less evenly distributed over an area of pavement surface, is therefore directed into two narrow strips, which gradually develop into a depression or rut, a condition which up to the present time has developed only in a small area, possibly about three ordinary blocks.

New Methods of Repair

In the repairing of these worn strips we have developed a new method which is much more satisfactory and economical than the old method of chopping out.

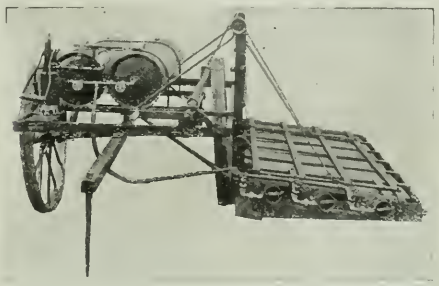
In working out this solution we have worked in close conjunction with the manufacturers of the "Pluto" asphalt surface heating machine, the Chausse Manufacturing Company of Detroit, with the result that we have perfected a machine which meets all of our requirements in a speedy and satisfactory manner. We had so far used this machine almost exclusively in the repairing of asphalt pavements, but its use should prove equally satisfactory in the resurfacing of old brick and cobble pavements with asphalt. Two views of the machine are shown herewith.

This machine, which has a heating hood measuring 6x6 ft., or 4 sq. yds., equipped with a battery of six "Chausse" burners, carries 53 gal. of kerosene oil in two tanks. The auxiliary tank feature is an excellent one, as it is never necessary to shut down operations on account of tank filling. The main tank holds 35 gal., while the other tank carries 18 gal. When one tank is emptied the operator merely switches to the other, and immediately fills the tank which has already been emptied. The surface heater is equipped with six burners to the battery. Each burner consumes approximately 1 gal. per hour.

The track surface heater is so designed that it may be operated close to car tracks without interferring with traffic. It folds like a jack-knife and is readily portable. This outfit has a battery of three "Chausse" burners with a heating capacity of 18 sq. ft. in three to five minutes.

Cost and Performance Data

In the completion of approximately 80,000 sq. yds. of asphalt repairing the surface heater reduced the cost from $1.22 to 97c per sqare yard. Two men and one of these machines will do the work of four men chopping out in accordance with old methods, but we are saving 1 in. of asphalt and 1⅛ in. of binder to boot. Hand-chopping meant that everything was taken out right down to the base. The machine has shown a capacity for heating sheet asphalt surface for proper handling to a depth of 1 in. on 400 sq. yds. per eight-hour day, although it has handled 600 sq. yds. in an eight-hour day under ideal conditions. Aside from the saving of 1 in. of asphalt top and the 1⅛ in. of binder, the machine speeds up the work in that it also saves the handling of this material.



TRACK SURFACE HEATER WITH HOOD LOWERED READY FOR OPERATION. OTHER VIEW SHOWS FOLDED UP READY FOR TRANSPORTATION.

A similar machine, especially designed for repairing ruts made in the pavement by the continual travel of automobiles and trucks in the same path, is 6 ft. long by 9 in. in width. This machine, which is easily handled by one man, has a capacity in heating asphalt surface for proper handling to a depth of 1 in. on 72 sq. yds. per eight-hour day. This special machine has two burners and is equipped with an 18-gal. kerosene tank. One man and one of these machines easily do the work of four men who were formerly employed in chopping out.

Drying Old Pavement for Asphalt Resurfacing

When using an old pavement of asphalt block, brick or granite as foundation it must be absolutely clean, with all moisture driven out by heat, so that the paint coat, of a proper consistency, which binds the wearing surface to the foundation, will adhere. The apparatus used in drying these old pavements is the 6-ft. by 6-ft. heater. If there are any loose integral parts they should be removed and the foundation

brought to grade by filling all depressions with a close asphalt binder, rammed and compacted, or, if deemed advisable, the old brick, if in good condition, could be filled. Foundations of this class should only be used on a street or road of light or medium traffic.

Significance of Data Collected in Iowa Road Census

Some surprising information concerning the use of roads in several Iowa counties has been obtained by a traffic census which is being carried on by the Iowa State College and State Highway Commission. The census is by no means complete, and the results obtained up to the present time may be materially modified by later information. They show, however, that the travel over Iowa roads is of a character that makes the improvement of such roads a matter requiring careful thought and sound judgment.

Data Taken at Eight Stations

The following facts relate to the travel counted at eight stations on highways leading into market towns of considerable importance. These roads are known as tourists' highways, yet the census shows, unexpectedly, that only 3 per cent of the traffic could be classed as tourist. The counts were made during the tourist season and should put to rest the assertion that road improvements are mainly for the advantage of people who make no payment of taxes toward the cost of the betterments. As a matter of fact, the great bulk of the traffic, 87 per cent, was between towns, what would be called interurban traffic by electric railway companies. The traffic from farms along the roads amounted to only 10 per cent of the total.

Interest of Towns in Country Roads

Attention is called to this distribution of the traffic because it emphasizes the fact that towns and cities have a direct interest in road improvements. Where more than three-fourths of the travel over main roads originates in towns along those roads, as is the case in the Iowa highways which have been under observation, it is self-evident that the expense of road improvement should not be borne mainly by the farmers, as at the present. The principle of rate-making for most classes of public service is that the charge for the service should be based on the use made of it. Road improvements form a class which heretofore has generally been exempt from the application of this principle. If more traffic enumerations are made like those in progress in Iowa, the injustice of putting most of the expense for improvement of market roads on farmers will lead eventually to a change in this policy.

Ratio of Motor to Horse Traffic

It has been known for some time that there are more automobiles in Iowa, in proportion to the population, than in any other state. The returns from the traffic census show that these automobiles are being used very frequently. They are not pleasure vehicles, for Sunday excursions. If the returns which included July 4 are thrown out because of the unusual traffic on that day, the proportion of motor vehicles to horse vehicles using the roads ranges from 2 to 1 on one road to 18 to 1 on another road. The average proportion at all eight stations, including the counts made on July 4, shows that eleven motor vehicles were used to one horse vehicle. It was also observed that these roads were carrying an average of 387 vehicles daily. When it is considered that this traffic was carried on dirt roads, as a rule, it is evident that the construction and maintenance of Iowa roads with the funds available for the purpose is a very hard problem to solve satisfactorily.

Motor Trucks and Earth Roads

One of the most instructive features of the census returns is the information regarding the use of motor trucks. On one road there were five horse-drawn trucks for every four motor trucks, the lowest proportion of the latter at any of the census stations. On one road there were 2.6 motor trucks for each horse truck and on another road there were 3.3 motor trucks for each horse truck. The average of all the stations was 1.1 motor trucks for each horse truck. It goes without saying that this proportion will be changed during the season when heavy trucking is being done from the farms to the market towns. It is expected that the proportion of horse trucks to motor trucks will be much higher then. Motor trucking has come so rapidly into favor among farmers, and trucking companies in cities are sending so many trucks into the country to haul agricultural products to market, that it would be surprising if the returns of traffic during the heavy hauling period do not show that motor trucks are rapidly becoming essential for the farmer.

This fact adds to the difficulties of maintaining dirt roads, such as are so numerous in Iowa. While something can be done by regulating the loads and speed of motor trucks to reduce their destructive influence on dirt roads, there is no form of maintenance, so far as is now known, which will keep a dirt road in good condition when many motor trucks are operated at more than very moderate speed over it. It would be interesting and instructive to determine the effect on dirt and gravel roads of trucks operated at different speeds, for it is possible that speed may be found the most important factor in determining the destructive effect of such vehicles. If this should prove the case, road officials will have a means of controlling the destruction of their low-cost roads until they are able to secure the funds for the construction of surfaces better adapted for such traffic.

Increase in Motor Traffic Makes for Flat Road Crowns

So long as earth roads were used only by horse-drawn vehicles there was no serious objection to giving them a high crown in order to shed the rainwater which fell on the roadway to the side ditches as quickly as possible. Now that such roads are used by automobiles the conditions are quite different. The best dirt roads are slippery in wet weather if they contain much clay. Skidding into side ditches is a dangerous occurrence. During June of this year two persons were killed and a large number were injured in Iowa by such accidents. The Highway Commission of that state has recently made public the following comment on the subject, in connection with some notes on an important main highway:

"Blade grader outfits have put it to natural grade, tho the cross-section for most of the distance shows altogether too steep an incline from center to side ditch. A terrific downpour of rain for half an hour between Delman and Charlotte made it almost impossible to stay out of the ditch. The passing of half a dozen cars encountered before dry road was reached again was a perilous undertaking, but, barring the steep slope, the blade grader work was well done and the road is in fine shape."

This practice of heavy crowning is particularly dangerous where the dirt roads are maintained by oiling, a method of maintenance which is growing in favor in Iowa. An oiled dirt road is considerably more slippery than a plain dirt road, when wet. It is evident, therefore, that dirt roads which are used to any extent by automobiles should have only enough crown to shed the water. Such a requirement also makes it necessary to maintain the roads in good condition by dragging and oiling under certain local conditions, in order that they may not become soggy in wet weather. While the expense of such maintenance might be considered unnecessary, in part, if a greater crown is used, the fact is that an unnecessary crown always leads to higher maintenance expense than is necessary with a road having the best cross-section. A high crown tends to concentrate the traffic along the center of the road and develops ruts and holes in the surface there.

Resurfacing Roadways with Tar-Macadam Cold-Mix

By John S. Crandell, C. E., Formerly Professor of Highway Engineering at the Pennsylvania State College.

A few years ago a cut-back tar was developed by one of the tar producers for the purpose of making repairs to bituminous, macadam and concrete without the necessity of heating the materials constituting the patch. The advantages of a cold patching material are obvious, and the cut-back tar met with instant favor.

Procedure in Using Cold Mix

The manner of using it is as follows: About 18 gal. to 20 gal. of cut-back tar are mixed with a cubic yard of crushed clean stone. This mix is set aside and allowed to cure for a

PATCHING WITH TARVIA K. P. IN JACKSON CO., MO.

few days. By the end of a week's time the more volatile oils have evaporated and the mix has begun to set up. It is then taken to the places on the road where it is needed. The spots to be repaired are dug out, making the sides perpendicular so as to prevent the patch from being crowded out of the hole by passing traffic. The mix is put in place, thoroughly tamped and a seal coat of the cut-back tar is painted over the new surface, which is given a dusting of sand, pebbles or screenings, and traffic admitted.

The whole operation is simple and repairs can be made quickly and easily by one man. On rainy days he can make up the mixture and store it away for future use.

Experience at Millersburg, Pa.

In 1916 the road authorities of Millersburg, Pa., went a step further and resurfaced part of an old and badly worn macadam with a 2 in. top made of local stone and cut-back tar (Tarvia Kold Patch).

PILE OF STONE AND SAND MIXED WITH TARVIA K. P. CURING.

The street is 30 ft. wide between curbs, and only the middle 16 ft. strip was treated. Results would have been better if the entire width had been resurfaced and if the thickness of the new top had been more nearly uniform. But, as it is, the experiment was very successful, and except for two or three spots where the mix was too "fat" the new top is in very good condition. The whole work was done by hand, which accounts for a lack of uniformity in the mixture.

Experimenting in Ohio

The State Highway Department of Ohio is at present experimenting with the cold tar mix for resurfacing in Franklin county and at Urbana. The ruts and depressions in the road are first patched with the mixture of stone and Tarvia Kold Patch, then the road is swept. A paint coat of K. P. is applied to the entire road surface. On this mixture of stone, sand and Tarvia K. P. is spread to a depth of 2½ in. and rolled. When the rolling is completed a seal coat of Tarvia K. P. is applied, and the new top is covered with pea gravel. The road is allowed to set up for two or three days before traffic is turned on.

The mixture is made in a concrete mixer. Various proportions of ingredients have been tried. The one that seems to give the best results consists of 1 cu. ft. of sand, 4 cu. ft. of crushed stone, 0.36 cu. ft. of Tarvia K. P. These are mixed for one full minute and the mixture is then dumped in a pile, as shown in the illustration. This pile looks like a heap of chestnut anthracite coal. A tarpaulin covers it in wet weather. At the close of day a quart of kerosene is put in the mixer with a couple of shovels full of stone and revolved a few times to clean out the tar and tarred stone.

This method of laying tar concrete appeals very strongly to contractors because of its simplicity, and also because the gang can be kept at work rain or shine. While it is raining, large stores of the mixture can be made up, and if enough is accumulated the entire gang can be put on the road in good weather to use up the excess produced. When made in large quantities and stored in large piles the mix can be laid after several weeks' storage.

In order to hasten the setting up action the Ohio State Highway Department is trying the experiment of spreading the newly mixed material in a 2 to 3-in. layer on the tar-painted road, keeping traffic off, and rolling after about two days' time. This method has the disadvantage that during the

MIXER, MIXING PLATFORM AND MATERIALS USED WITH TARVIA K. P.

interim it may rain. While the rain itself cannot injure the mix, which is waterproof *per se*, it may cause mud or clay to find its way from the old roadbed into the new material.

The mixer that is being used is manufactured and sold by the Jaeger Machine Company of Columbus, Ohio, at $440. The cut-back tar which conforms to the Ohio state specification is Tarvia K. P., furnished by The Barrett Company.

Leads World in Wealth.

The per capita wealth of the United States is $2,030; that of Great Britain, $1,751; of France, $1,522; Germany, $1,355. Our present national debt is $33 per capita, or will be after the $1,800,000,000 war budget is passed; that of Great Britain, $370; France, $360; Germany, $290. We could pay our debt 169 times over without being "broke." We have $25,000,000,000 of "liquid" money, subject to check, in our bank deposits. Our trade balance in 1902 was $478,000,000; in 1916 it was $2,000,000,000, a 500 per cent. increase in fourteen years.

The Improved System of Road Maintenance in Washington

By George F. Cottcrill, Chief Engineer, Washington State Highway Commission, Olympia, Wash.

An important feature of our work this season was the production of bulletin No. 9, entitled: The Rules, Regulations and Requirements for the Maintenance of Primary Highways as Prescribed by the State Highway Board.

Prior to this year, 1917, the primary state highways, which had been constructed by the state, were being directly maintained by the State Highway Department from a state appropriation therefor which had gradually increased to $75,000 annually, but which was notoriously inadequate. Had that system been continued the maintenance fund would at least have required to be doubled. Instead of doing that, the state legislature of 1917, in its wisdom, took all maintenance away from the State Highway Department and imposed it on the several counties, providing for an apportionment to the counties of the motor vehicle license revenue—now reaching $500,000 per annum and increasing—for maintaining the constructed primary state highways within their borders, and also a certain class of improved main county highways. The aggregate mileage of primary state highways subject to this maintenance is about 1,500 miles, and the improved main county highways to which this fund is also applicable exceeds 3,000 miles as a total.

The state legislature, however, made requirement that the maintenance of these constructed primary state highways by the county authorities should be "under such rules, regulations and requirements as may be prescribed by the State Highway Board." The law also provides for enforcing the prescribed standard of maintenance if counties become delinquent.

Bulletin No. 9 embodies these maintenance rules, regulations and requirements, which have been in effect since June 7, 1917. The department had no maintenance specifications or prescribed standards from other states to draw from, hence this is "new matter" drawn from our experience and judgment as to methods, standards and cost reports of highway maintenance. We are now four months on our first year of this dual system of state-prescribed, county-executed maintenance. It seems to be working ont well, but judgment as to its ultimate wisdom must be suspended, at least until we have gone through an entire year, and especially our winter, or "rainy season," of western Washintgon.

Road Reconstruction and Maintenance in Rhode Island

By Irving W. Patterson, Chief Engineer, State Board of Public Roads

The work of the State Board of Public Roads of Rhode Island was handicapped somewhat this year by the high prices which prevail. Our funds this year were appropriated solely for reconstruction and maintenance. Our main trunk lines have been practically completed for several years, but a great many miles of the older construction are wholly inadequate to withstand the traffic to which they are subjected today. Reconstruction and maintenance are our big problems.

Perhaps the most interesting feature of our reconstruction work is the attention paid to foundations. As a rule the state roads of Rhode Island are subject to a year-round commercial traffic. In the winter and early spring the use of heavy commercial vehicles makes imperative heavy foundations. Our construction work this year has been almost wholly bituminous macadam. This type of construction has given us very good satisfaction where sufficient attention has been paid to foundations and drainage. Heavy stone fills and an "insulating" cushion of coarse sandy, gravel are laid wherever the soil conditions are deemed bad enough to warrant it.

Maintenance of Waterbound Macadam

The maintenance of our waterbound macadam roads is almost a hopeless task. Few of these roads were designed for the heavy traffic which they are called upon to carry today; many of them are so old that they have outlived their usefulness, and the erratic method of financing maintenance work in the past has had its usual accumulative effect. Upon those roads completely worn out and upon those roads which lack the necessary foundations we have not spent large amounts for maintenance, working upon the theory that it is preferable to set aside all that we possibly can for reconstructing these roads in a permanent manner as rapidly as possible.

Maintenance of Bituminous Macadam

The maintenance of our bituminous macadam roads is carried out wholly by section gangs equipped with a light tandem roller, heating kettles and the necessary small tools. We find that a patrolman's work upon bituminous macadam construction is somewhat limited by reason of lack of equipment necessary to repair in a permanent manner large cuts made for the purpose of installing public utility structures, such as gas pipes, electric wires, sewers, etc. Equipped as they are, our section gangs are capable of doing very effective maintenance work, even reconstructing short sections of road which have failed.

To date no actual construction work has been done under our Federal Aid Road Act. We have recently executed the project agreement for our project No. 1. It is expected, therefore, that construction work will follow in the very near future.

The Concrete Type of California State Highway

The California State Highway Commission has developed what may be called its standard type of pavement, consisting of a relatively thin concrete base covered and protected by a thin bituminous wearing coat. The concrete is laid without expansion joints and upon a well consolidated subgrade.

More than nine-tenths of the expenditure for the pavement is placed where the traffic has little chance of destroying the investment. The bulk of the road cost goes into the grading, drainage appliances and a solid concrete foundation. The wear and tear of traffic does not come in contact with this foundation, as the concrete is protected by a surface coat of asphalt and mineral aggregate. Such a coat is easily applied and gives a high return in wearing qualities for its cost. This wearing coat does not roll or form ridges and hollows. It adheres firmly to the concrete pavement, and at the end of three or four years it may be renewed by a new coat of asphaltic road oil and rock screenings.

The oldest concrete roads built by the commission have been protected by the thin bituminous wearing coat for nearly four years, and the maintenance cost has been very low.

Judicious Use of Machinery and Dynamite Lowers Road Grading Costs

A contractor on a Pennsylvania road has completed his work at a lower cost than was attained on other sections of the road by using machinery to an unusual extent. On account of the high price of labor and its scarcity in that section he used a steam shovel in all cuts, low-strength dynamite to loosen the material and speed up the work of the shovel and automatic dump wagons to remove the earth and shale as it was excavated. The outfall drainage ditches were blasted out with dynamite, thereby reducing the cost of excavation and trimming the slopes. The work was finished on time in addition to being done at a relatively low figure, for the conditions, while the other contractors were unable to finish on time on account of the difficulty of securing labor to carry on the work by the older methods utilizing merely plows, scrapers and hand work.

Water Works Design and Construction

Design and Construction of 1,500,000-Gallon Reinforced Concrete Reservoir

By H. F. Blomquist, City Engineer, Mankato, Minn.

In the design of a reinforced concrete reservoir of the type here described there are some features upon which designing engineers differ in opinion, said Mr. Blomquist, in addressing the Minnesota Surveyors' and Engineers' Society. The present discussion dwells more on these features than on the general design of the reservoir.

Special Features of Design

The reservoir is built on a hill composed of red and blue clay. The floor is about 17 ft. below the original ground line and filling around the walls extends to the height of the high-water line, which is about 8 ft. above the original ground line.

Special attention is called to the following features of design:

1. The circular plan compared to rectangular or square.
2. The amount of horizontal reinforcement in the walls and the consideration given the earth pressure on the walls to offset the tension due to the inside water pressure.
3. The conical roof, compared to a flat slab.
4. Expansion joints between floor and walls.
5. The provisions made for cleaning.

Economic Plans

Where a reservoir is built entirely in solid ground it has been found that the thrust of the outside earth against the walls is sufficient to counteract the water pressure on the inside, and therefore no reinforcement is necessary in the walls when the reservoir is filled. Under such conditions a square or rectangular plan will somewhat reduce the cost of construction because of less expensive centering.

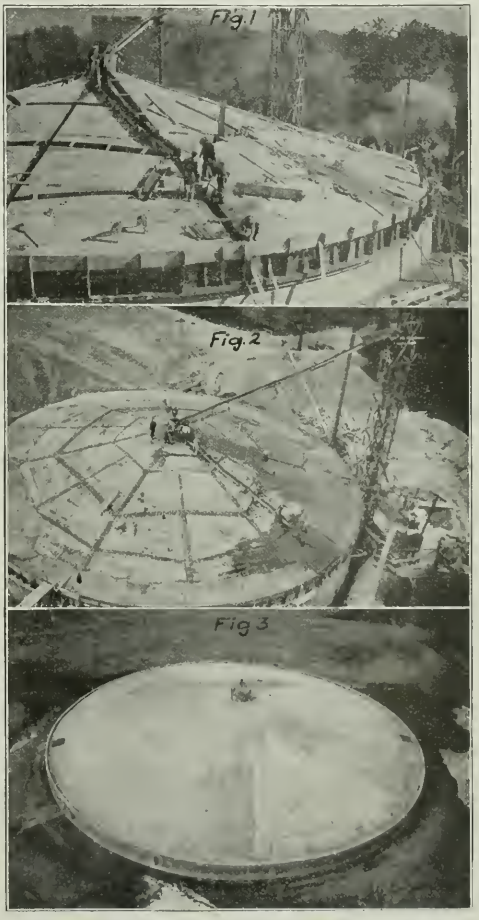
However, when the reservoir is empty the earth pressure on the outside will create stresses in the walls opposite to those caused by the inside pressure when filled. For this reason reinforcement is necessary to take care of this negative stress, unless some other means is provided, such as a gravity wall or other form of construction. Under these conditions a circular plan will not require horizontal reinforcement or other means of overcoming negative stress when the reservoir is empty.

If horizontal tension in the walls is to be taken care of by reinforcement, the circular wall requires the least amount for a given internal pressure. It will also counteract the thrust of the outside earth against the walls when the reservoir is empty without producing tension in any part of the walls. It may be said in passing that the outside thrust against the walls in some instances may be very large, especially if the earth has been saturated by water from leakage or other causes.

The circular types of construction cost more than the square or rectangular for the same amount of wall, but the saving in reinforcement and in volume of concrete or masonry is sufficient to offset the difference in cost; therefore I believe the circular plan is the better to adopt in all cases where space will permit its use.

Roof Design

Where a covering over a reservoir is desirable, the cheapest construction, if concrete is used, undoubtedly is a flat slab; it may, of course, have pitch to provide proper drainage. The method of supporting the roof will depend on the depth, size and shape of the reservoir. If the reservoir is not deep, a large number of pillars from the bottom will reduce the size of beams, and vice versa. To find the most economical construction, each case must be studied by itself. There will always be a certain length of span at which the cost of construction will be the minimum, such a condition that by either increasing the length of spans and size of beams and decreasing the number of supports, or by decreasing the length of span and increasing the number of supports, will result in an increase of cost. The most economical condition must be found by trials and estimates in each case.



CONSTRUCTION VIEWS ON MANKATO RESERVOIR. FIG. 1—POURING THE ROOF BEAMS. FIG. 2—POURING THE ROOF. FIG. 3—ROOF JUST COMPLETED, GROUT SURFACE WASH NOT YET FINISHED.

There are instances, however, when economy must give way to some other desirable features. Too little attention has been paid in this country to the aesthetic features of permanent structures. In the use of concrete the general appearance of a structure may be greatly improved at very little cost above a strictly economical design. This, however, is a question outside the scope of this article.

Having given some consideration to the aesthetic side of the result, the most desirable covering was a conical shaped concrete roof supported by reinforced concrete beams inclosed with a curtain wall above the top of the wall proper. The roof rests on the outside walls and seven pillars, placed one in the center and six in a circle 60 ft. in diameter around the center pillar, making the longest beams 30 ft. in horizontal length between centers of supports.

The roof slab is 4½ in. in thickness, being 4 in. of 1:2:4 concrete and ½ in. of mortar coating troweled to a smooth, hard finish. The roof slab is reinforced with ⅜-in. steel rods, 8-in. centers, laid one way only, and with a network of steel wire netting consisting of 4-in. mesh with double No. 8 wire longitudinally and No. 12½ crosswise. The amount of reinforcing is sufficient to carry a loading of 100 lbs. per sq. ft. of surface, besides its own weight. The roof beams are so arranged as to place them about 12 ft. apart.

In the design of the roof slab no consideration was given to the arch action of the slab due to the conical shape of the roof. This is a variable amount at different places of the roof, and while it would be sufficient to consider in calculating the amount of reinforcement, it was not taken into account; its value will, therefore, go toward increasing the factor of safety.

Reinforcing

The necessary amount of horizontal reinforcement in the walls and the value of the earth pressure or thrust that may be relied taken to neutralize the stress due to the inside water pressure will, of course, depend on the nature of the ground and the care exercised in filling around the walls after the forms are removed. With care in refilling the clay soil, this earth thrust ordinarily is more than sufficient to counteract the pressure due to water extending from the surface of the ground to a given point in the wall. There would, however, be certain times when the upper layer of the earth, say the surface layer about 6 ft. thick, would not act as a support to the walls, because during very dry conditions of the ground contraction takes place in it, so that it recedes from the adjoining surfaces; this is also true in very cold weather when the ground is dry and freezes.

For this reason, no support from the filling or upper 6 ft. of the ground surface should be assumed. In our design the horizontal reinforcement in the upper 15 ft. of the wall is sufficient to take the entire tension due to the inside water pressure at a unit stress of 16,000 lbs. per sq. in., with a surplus amount near the top to take care of ice thrust in case of ice formations on the water. The reinforcement in the lower 10 ft. of the walls is not sufficient to take all the tension at 16,000 lbs. as a unit stress. About 40 per cent of the tension is here assumed to be taken up by the outside earth thrust, and with no tension being assumed in the concrete it is safe to assume the design has the proper factor of safety.

The floors consist of 10 in. of concrete reinforced with ⅜-in. rods laid both ways, 9 in. apart. The floor was constructed after the walls and roof had been completed. A ¾-in. expansion joint connects the floor and walls, also the floor and pillars. This joint was caulked with oakum and filled with an asphalt filler. The floor slopes from the wals toward the center, being 18 in. lower at the center than at the walls.

Methods of Construction

On account of the firmness of the ground it was intended to trim up the sides after the excavation had been made, so that no outside forms would be necessary for the walls below the surface of the ground. The hard rains during the time of excavation caused some slides to occur, so that forms were needed for about half of the walls.

After the excavation had been completed the forms for the entire walls and the six large roof beams radiating from the center, also the supports for the centering of the roof, were built before any part of the wall, except the foundation below the floor line, had been poured. The reinforcement was placed in the wall at the time of building the forms, and was supported by two 2-in. angles laced together for this purpose. These supports rested on the concrete foundation already poured for the walls, and were placed at intervals of 10½ ft. and carried the entire horizontal reinforcement. These angle supports, together with ¾-in. rods 2 ft. apart, form the vertical reinforcement of the walls.

VIEW OF SUPPORTS OF MANKATO RESERVOIR ROOF FORMS.

All the concrete for the entire structure, except for the foundations and the floor, was distributed from the hopper at the center of the roof, the radiating forms for the roof beams acting as chutes to different points around the wall.

The mixer was placed in a pit below the surface of the ground near the wall and the concrete hoisted in a tower about 60 ft. above the surface of the ground, from which it was run thru an inclined chute to the hopper at the center of the roof.

All the material was on the ground before pouring of the walls was commenced, because they were to be poured in a continuous operation to avoid horizontal seams forming where concrete would set between pourings if done intermittently. The sand and crushed stone were taken from the material bins to the mixer in dump cars.

The pouring of the walls was done in four days and four nights, without stopping the mixer at any time for more than one hour, and the concrete deposited at different points around the wall in rotation, so that no part of the surface had set before new concrete was added.

Small openings in the forms were left for working the concrete in the walls to prevent voids, and these were closed up as the filling progressed.

The walls are 24 in. thick at the bottom and 15 in. at the top. After the walls had been completed, the forms for the roof baems were cleaned and completed and the centering laid for the entire roof slab before the beams were poured. The

centering for the roof slab was all supported by staging from the bottom. The form work, centering and supports for roof beam and slab required about 100,000 ft. of lumber, but the greater part of this did not require cutting, and therefore the waste was not more than about 15 per cent.

The reinforcement was then placed in the beams and all the beams and curtain wall poured. After the beams were completed the reinforcement was placed for the roof, and the concrete afterwards poured. The concrete was mixed sufficiently stiff to prevent sliding or running when placed on the inclined roof, which has a rise of 15 ft. in 50. The roof slab was finished with a ½-in. mortar surface troweled to a hard, smooth finish.

The mixture of the concrete in the foundations is 1:2:5, and of all the walls, roof and floor is 1:2:4. Crusher run limestone passing a 2-in. ring was used for the coarse aggregate. As an aid toward water-proofing the concrete in the floor, walls and roof slab, 20 lbs. of hydrated lime were used with each barrel of cement used, the lime being first thoroly mixed with water.

For water-proofing the concrete surfaces two plastering coats were applied, consisting of 1 to 2 cement mortar, to which was added Trus-Con Water-proofing Compound, and then the surfaces given a brush washing of cement grout.

Provisions are made for draining out all the water in cleaning, and since there is a separate system of water supply for the hill district, 4-in. pipe line from this system was laid into the reservoir and provided with a 2½-in. fire hose nozzle, so that a fire stream of 60 lbs. pressure may be used for cleaning.

The reservoir has been in use about two months and no visible leakage has so far taken place.

The work was done by the J. B. Nelson Construction Company, of Mankato, under contract, at a cost of $19,373.

The new reservoir is used in conjunction with the old masonry reservoir of about 800,000 gals. capacity, and was constructed primarily for the purpose of increasing the storage capacity of the water works system for fire protection.

Construction Plant and Methods Employed in Building the Nepaug Dam of the Hartford Water Works

By H. W. Griswold, Assistant Engineer, Hartford (Conn.) Water Works

The contract for the masonry for Nepaug dam and appurtenances, together with about one-half mile of highway, was awarded to Fred T. Ley & Co., Inc., of Springfield, Mass., in March, 1914, and was completed by them in July, 1917.

Dam Section

The dam was built largely of cyclopean masonry with a maximum height above the surface of the rock of about 130 ft. and a length of 600 ft. In section it is 20 ft. wide at the top, 90 ft. wide at the bottom and is curved upstream to a radius of 390 ft. An overflow section was built in the center of the dam, the highway being carried over it on a series of 5 concrete arches, each having a span of 36 ft. The overflowing water falls down a series of steps into a pool lined with concrete, rubble masonry and paving at the base of the dam. The difference in elevation of the surface of the water in this pool and that in the reservoir is 100 ft. An inspection gallery, 7 ft. by 5 ft., entered from the lower gate chamber, runs parallel with the axis of the dam near the upstream face and from this gallery seepage wells are carried down to rock and up to reservoir flow line.

Construction Railway

For the transportation of material and supplies for the construction it was necessary to build a mile of standard gauge railroad up the Nepaug ravine to the damsite from the New Hartford branch of the New Haven railroad. The grading for this spur was done with a ¾-yd. steam shovel, and a portable boiler and steam drill for the rock work. As soon as steel was laid on the spur, a commissary and bunkhouse of the usual type were built and the construction of the cofferdams and flume begun, said Mr. Griswold in addressing the annual convention of the New England Water Works Association.

The Cofferdams

The upper cofferdam was about 150 ft. upstream from the axis of the dam, the lower 175 ft. downstream from the axis, and both were of the rock-filled crib type, with tongue and groove sheet piling and toe-fill on the river side. The flume was built along the foot of the west slope and was framed and planked as suggested on the contract drawings. This flume was removed as soon as the two central blocks of the dam were built above the river bed, and thereafter the river was diverted through a 10 x 10 ft. culvert in one of the blocks with a flume from the downstream face to below the lower cofferdam. In filling this culvert with concrete, after the dam was completed, the part between the upstream face and the inspection gallery was first poured, the water being carried around this section in a small by-pass which had been left in the concrete. This by-pass was next filled and then the remaining section down stream from the inspection gallery was poured and the whole closure grouted to insure water-tightness.

Excavation

Excavation was started with the steam shovel as soon as grading for the spur track was finished, the excavated material being hauled by train to a spoil bank in a side valley about one-fourth mile below the damsite. Earth at the top of the east slope by team to spoil bank below the dam, at the top of the slope, and material (largely sand) on the east slope was sluiced down to the steam shovel below with a fire hose. The same method was tried on the west slope, but was not successful, and the excavation there was completed with pick and shovel.

The underlying rock, a mica schist with numerous pegmatite dykes, had a dip of 45 degrees to the west, so that the east slope showed comparatively smooth ledge, while the rock on the west slope was very irregular. Just east of the river was a ridge of fairly sound rock, and between this and the foot of the west slope, under the bed of the river, was an area of hydrated mica schist, which had the unpleasant characteristic of disintergrating into a sort of blue mud on exposure to the air in the presence of water.

Practically none of the dam is built on the original surface of the rock, it being necessary to excavate from 2 to 30 ft. before rock suitable for a foundation could be found. The upper part of this excavation was done by drilling and blasting, and the balance by barring and wedging. Spoil was handled by derricks and skips into cars.

A suitable foundation being secured, the next step was to make a water-tight cutoff in the rock, 10 to 20 ft. wide, near the upstream face by forcing grout under pressure into the seams of the ledge. That a practically water-tight cutoff was secured for the full length of the dam is shown by the very small leakage through the seepage wells with the reservoir within 6 ft. of being full.

Laying Out the Work

The method of laying out the work is of special interest, as nearly every surface of the dam is curved in at least one direction. The upper part of the downstream face of the non-overflow section is curved both vertically and horizontally. The method used, which worked out very successfully, was devised largely by G. W. Penfield, who was in charge of the field party, and consisted primarily of a dual system of rectangular and polar co-ordinates. The origin of polar co-ordi-

nates was at the center of the sweep of the dam, the axis of which was curved to a radius of 390 ft. and over this point a 40-ft. tower for a transit station was built. A base line was run up the valley from this tower, and a second base line, with concrete monuments at either end, was run at right angles to the first and tangent to the axis of the dam. From these base lines the rectangular co-ordinate system was extended as needed. All monuments were set by rectangular co-ordinates and checked by triangulation, the monuments at the ends of the east and west base line and the origin of polar co-ordinates forming the primary triangle. In laying out face forms, the expansion joint lines on either side were first given from the tower and the intersection of the face form with these lines obtained by measuring a computed distance along the expansion joint lines from their intersection with an east and west rectangular co-ordinate line. Curve of form between expansion joints was given by ordinates from the eighth points of a chord, formed by pulling a line between the points on the expansion joints. Batter and radius boards were also used in checking and truing up forms.

Concreting

In general, forms were built of 2-in. lagging with 2 x 6-in. studs on 2-ft. centers and 4x6-in. rangers. To save time in erection, lagging was cleated into panels 8, 10 and 12 ft. long. Forms were wired to plume stones or pins set in concrete.

The cement used for concrete work was tested at the mill and on the job. Storage was provided for 60 cars, or 10,000 bbls. Crushed trap rock was shipped from the quarry at Tariffville in bottom dump, steel gondolas, from which the stone was dumped directly into the bins. Bin capacity was 2,000 cu. yds. stone and 1,000 cu. yds. sand and stone for plums and heavy riprap was quarried in the same valley. Sand was obtained from a glacial deposit in the valley used as a spoil bank. Boulders, picked out of the river with a locomotive crane, were also used for this purpose.

Concrete was mixed in two 1-yd. Ransome mixers served by skip cars running in a tunnel under the bins. There was a wooden tower for each mixer, but both towers dumped into the same chute. Chutes were suspended from derrick guys or cables put up for that purpose.

Placing Concrete in Form

The method of placing concrete in the form was a new wrinkle which worked very successfully. It consisted of bringing the end of the main chute to a 30-ft. gin pole, fitted with two horizontal booms with a swinging radius of about 270 degrees. The upper boom was about 20 ft. long and the lower 10 ft. long. By suspending two 10-ft. sections of chute, one from the end of the main chute and the tip of the lower boom, and the other between the lower boom tip and a trolley running along the upper boom, concrete could be placed at any point within the swing of the upper boom. A 3-ft. square box was built around the gin pole and the resulting hole in the concrete was filled up the next time concrete was poured in that block.

Before placing concrete on the rock foundation the latter was washed perfectly clean with a hose stream, all loose rock removed and the whole surface covered with grout, put on with a fire hose under about 80 lbs. pressure. It was then plastered with mortar which was worked into all large cracks and holes.

The surface of each day's run of concrete was broomed or scraped with hoes the morning after it was laid, and before fresh concrete was placed it was thoroughly washed and broomed with grout. A crushed stone drain was laid between seepage wells to intercept seepage on a day's work joint. The expansion joint seepage wells were closed with concrete blocks, and the whole surface plastered with mortar. We then placed 1:3:6 concrete in 1-ft. layers, beginning at the downstream face. Along the upstream face a richer mixture (1:3:5) was used for a width of about 3 ft. No drawboards were used. Plum stones were cleaned with a hose stream on the cars and placed by derrick. In forms where chutes could not be used concrete was placed with 2-yd. Haines buckets. About 375 cu. yds. was an average day's work with chutes, and bulkheads were built where necessary to give a depth of from 6 to 8 ft. for a day's work.

In addition to the plums which stuck up above each lift, a key 6 in. deep by 3 ft. wide was left at the upstream face, and usually a section 4 to 6 ft. wide along the downstream face was left 6 in. higher than the rest of the run.

Sidewalks, the roofs of the gate chambers and tops of parapet walls were trowel finished, spillway steps were floated and sides of parapet walls and all panels were rough pointed. The downstream face of the non-overflow portion was sand blasted.

Cost

The cost of the work was approximately half a million dollars, and the following is a list of the principal quantities: Earth excavation, 35,000 cu. yds.; rock excavation, 20,000 cu. yds.; refilling and embanking, 17,000 cu. yds.; cyclopean masonry, 75,000 cu. yds.; mass concrete, 4,000 cu. yds.; concrete surfaces finished, 40,000 sq. ft.; Portland cement, 80,000 bbls.; large cast iron pipe and special casting, 40 tons; metal for reinforcing concrete and for waterstops, 100,000 lbs.; miscellaneous cast iron, wrought iron and steel, 35,000 lbs.

Water Works Maintenance and Operation

Procedure in Maintenance and Operation of McPherson, Kans., Water and Electric Plant

By Arthur Groesbeck, Superintendent Water and Electric Department, McPherson, Kans.

The management of a municipal public utility, even in the small city, is largely an engineering problem. The manager of the small city utility cannot often call in expert engineering assistance and the first requisite of a good manager of such a utility is that he have knowledge of engineering.

Reorganization

Prior to 1914 the city of McPherson had the council form of government consisting of a mayor and eight councilmen. The water and electric department was placed under the management of a water and light commission of three men, appointed by the council, and they in turn hired a chief engineer who had charge of the powerhouse, an electrician who had charge of the lines, a cashier and a collector. All the work for the water department was turned over to the plumbers, without specifications as to how the work should be done. Each plumber had a different way of setting meters and installing services. They also repaired meters, or attempted to, and at least 50 per cent. of the meters were under-registering. The only records of the plant operation were the invoices of coal and supplies, and no attempt was made to keep a cost analysis of the production.

The water and light commission was abolished in September, 1913, and a superintendent appointed to take charge of the department. As can be imagined, his was no easy task, but he succeeded in getting rid of several superfluous employes, including the chief engineer, and hired a very competent man for this position. The superintendent was reappointed by the commissioners, but resigned in a short time, and the writer was appointed in August for the unexpired term.

Looking Into Operating Conditions.

In looking over the books the operating expenses seemed to be out of proportion to the output of the plant. The chief

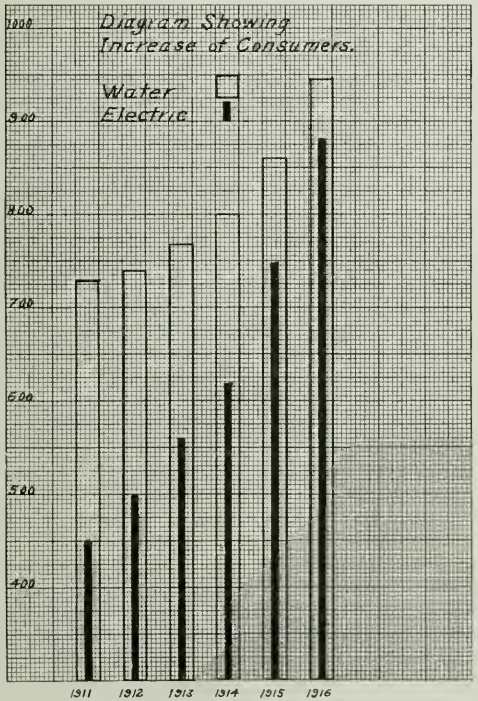


FIG. 1—INCREASE IN CONSUMERS, McPHERSON, KANS., WATER AND ELECTRIC PLANT.

engineer had designed a station log and was endeavoring to keep records of the operation of the plant. He was not having much success, as this necessitated a great deal more labor on the part of the engineers, and as they had not been in the habit of doing more than keeping up steam and the machinery oiled, they did not take kindly to his orders. They even informed him that they were hired by the commissioners and expected to take orders only from them. A notice from the manager's office that the department was out of politics and that their jobs depended on their ability and willingness to do the work required of them had the desired effect of bringing them into line.

In order to attack the problem in a systematic manner an inventory of the operating conditions was taken. Were the boilers clean? Were the boiler settings tight and the furnaces in good condition? Were the firemen using the proper draft and were they using the dampers instead of the ash pit doors, thus reducing excess air? Were they using the best method of firing? Were the blow-off valves tight and used properly? Was the feed water heater clean and giving maximum temperature? Were the combustion chambers clean and the tubes free from soot? Were all the exposed steam lines covered? Were the engines and pumps operating at maximum economy? Were the valves properly set?

Improving Boiler Room Efficiency

The word *No* answered all these questions. After removing the scale, some of which was over half an inch thick, it was necessary to restubb the tubes, but this item of expense was very small compared with the cost of fuel that had been wasted due to this scale. After cleaning the boilers and heater we used a cheap chemical fed continuously into the heater and

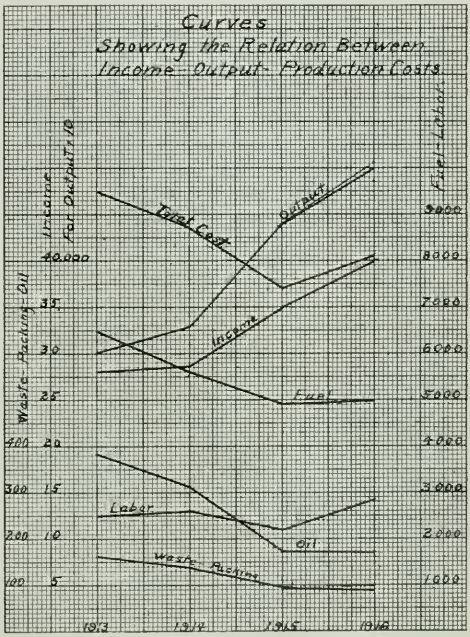


FIG. 2—CURVES SHOWING RELATION BETWEEN INCOME, OUTPUT AND PRODUCTION COSTS, McPHERSON, KANS., WATER AND ELECTRIC PLANT.

our boilers today, after over two years operation, are free from scale. The boiler settings were in such shape that the inrush of cold air would draw out the flame of a candle at nearly every point where it was applied. The settings were repaired and painted with two coats of asphalt which has proven to be an excellent remedy for leaky boiler settings. The firemen were instructed as to the best method of firing and the proper use of the dampers. It is very hard to induce a fireman to change his way of firing, but we accomplished this by running tests with different methods and giving the firemen the results of the tests. Pipe covering was purchased and all the steam lines covered. We also purchased an indicator and by using it regularly are enabled to keep the valves properly set. A recording steam gage gives us constant steam pressure instead of the previous variation from 60 to 145 lbs. and a recording volt meter in the manager's office greatly improved the voltage regulation of the system. Scales were installed in the boiler room and the coal is now all weighed and checked against the output for each shift. After making these changes one boiler easily carried the load where previously it had required two.

Going After New Business.

We were then ready for new business, and the first step along this line was a reduction in the rates and a power and cooking rate of 4c was established. We began our advertising campaign for electrical cooking in December, 1914. The services of a very competent demonstrator were secured for a week to demonstrate the ranges, as we felt that this was the only

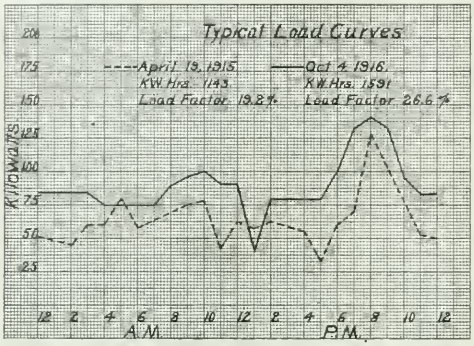


FIG. 3—TYPICAL LOAD CURVES, McPHERSON, KANS., ELECTRIC PLANT.

way of getting the proposition before the public and of showing the many advantages of the modern way of cooking with electricity as compared with the old way. Approximately 500 people attended our demonstration and eight ranges were sold during this week.

In connection with our advertising campaign we secured several reels of moving pictures, which were run at the theaters free to the public, showing the many disadvantages, trials and tribulations of the housewife cooking with coal, and the comfort and happiness afforded by changing from the old-fashioned way, with all its dirt, soot and delay, to the clean and economical method of cooking with electricity. We used other electrical appliances which he cannot afford to do without.

New Rate Schedule

On January 1, 1916, a new rate schedule went into effect, giving another reduction in light and water and also in the cooking rate. Ordinances were passed defining in detail the policy of the department and were published in booklet form. We have had numerous calls for these ordinances and feel flattered that they have been adopted by other cities. We also passed an ordinance requiring a license and a bond from all persons doing electrical wiring in the city. All wiring is inspected and must pass the code before connection is made with our system. Our customers receive the benefit of this as we have obtained lower insurance rates on several buildings by having the wiring brought up to code.

Operation Data

Fig. 1 shows our increase in consumers from 1911 to 1916. The increase of electric consumers in 1915 is due largely to the low power and cooking rate, and the increase in 1916 is the result of the reduction in rates and our campaign for new business.

Fig. 2 is a collection of curves showing the relation between income, output and production costs from 1913 to 1916. One will note here the effect of stopping leaks in the plant had on the cost of production. The cost of fuel, oil, waste and packing has been reduced in spite of the fact that the output has increased 66 per cent. and the income 43 per cent.

Fuel Expense Reduced 22 Per Cent.

Fig. 3 is another way of showing in a graphical manner how the income was expended in 1913 and 1915.

Fig. 4 shows two typical load curves and gives at a glance the effect of a range and motor load. From midnight to 6 in the morning the load is fairly constant and consists principally of street lighting and the pumping load. The greater part of the leak at 10 a. m. is due to ranges, as one will notice; this drops off in the afternoon to a constant load till 5 p. m., when the ranges are again started to prepare supper.

Fig. 4 shows the method we use in comparing our outppt and cost of production from month to month and from year to

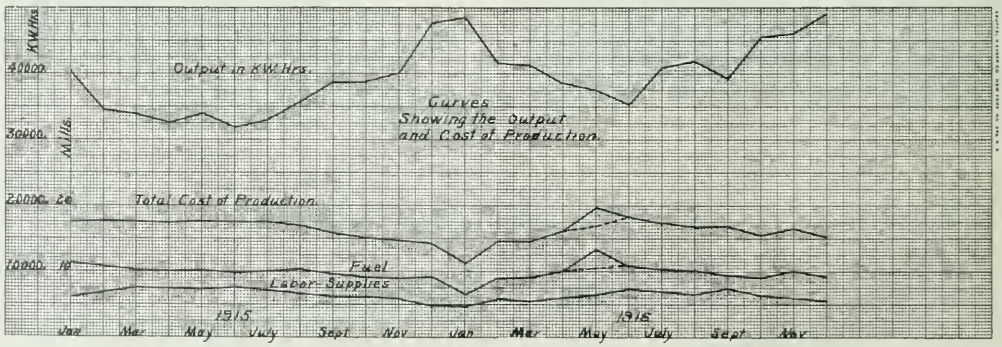


FIG. 4—CURVES SHOWING OUTPUT AND COST OF PRODUCTION, WATER AND LIGHT PLANT, McPHERSON, KANS.

considerable space in the daily papers, circulated hand-bills over the entire city, and used inserts in mailing out our monthly bills.

As the cooking load is very essential to us for the improvement of our load factor, it is continually being solicited by means of advertising and personal work of our employes and also by the local dealers handling the ranges. When houses are wired we impress upon the owner the importance and necessity of having provision made for an electric stove and year. One will notice that as the output increases the unit cost decreases and this is one reason we are so anxious to build up our day load.

Curves similar to these, tables and pictures are published in the city's annual report. We strive to publish a report that is readable and it is our desire that every citizen will read the report. In this way he knows what we are trying to do, will take an interest in the department and takes pride in boosting for us.

We are proud of the things we have accomplished with municipal ownership, yet realize that we have done nothing any other plant cannot do if the same remedy is applied, namely, take the department entirely out of politics, place it on a business basis and give the management to an engineer-business man with this one restriction, that he must get results.

The sharp increase in the cost of fuel shown in the diagram, Fig. 4, for May, 1916, was due to several cars of very dirty and poor coal received at that time. By our system of plant records we were able to convince the coal company of this fact and they rebated us so that the actual fuel cost is represented by the dotted line.

Plant Improvements in 1917

Since the first of the year we have entered into contracts for a new generating unit, consisting of a Skinner Universal Uni-flow engine direct connected to a 312 KVA General Electric generator. The necessary switch-board panels and instruments are included in this contract. The new boiler-room equipment will consist of a 250-h.p. water-tube boiler, feed-water heater and boiler feed pumps. We are making a departure from the usual practice of boiler setting and are setting this boiler so that the distance from the grates to the heating surface will be a minimum of 7 ft. We will make quite a fuel saving and will obtain practically smokeless combustion. We have just completed a 125-ft.x5-ft. concrete chimney and a 300-gal. per minute deep well with pump head and driving motor. All of these improvements will be paid for from the earnings of the department. When these improvements are made we will have the largest station of any city this size in the state.

Extending Light Lines to Farmers

In order to extend the benefits of municipal ownership we are building transmission lines into the country to supply the farmers with light and power. We have one line built and contracts signed for another line 6 miles long, and are now working on estimates for a line to one of the smaller towns near here.

Using Permanent Concrete Covering to Prolong Life of Steel Pipe

On a California pipe line 10,000 ft. of 24 in. steel pipe used in inverted siphons working up to 80 ft. head, after 30 years of use, was giving away at places and called either for replacement or repair. In other places the steel had pitted badly. It was necessary to shut down and put concrete bands on the pipe to prevent the sudden failure, which was imminent.

Forms

Cylindrical concreting forms, swung from A frames, were placed around the pipe preparatory to casing it with a shell of reinforced monolithic concrete.

Forms were made of Oregon pine and, where particularly smooth surface finish was required, were lined with 26-gauge sheet metal. Forms were made in 8-ft. lengths where the clear diameter of pipe covering was 24 in. For 14 and 18-in. diameters forms were made in 12-ft. lengths. The work was done as follows:

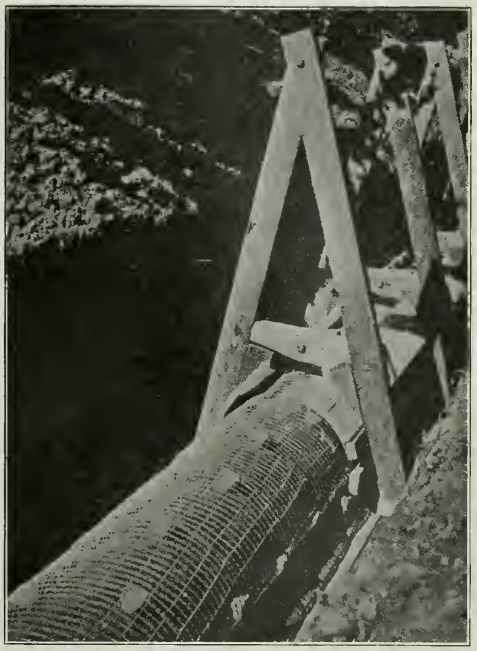
The steel pipe was uncovered and thoroughly cleaned with steel brushes. The ground under the pipe was shaped properly and 2x4's were spaced and bedded on each side to support the forms as shown herewith.

Reinforcing

Wire mesh in convenient lengths was then wound spirally around the steel pipe which was used as the inside form. Mesh was held the required distance from the pipe by precast concrete blocks made in the form of trunacted pyramids 1½ in. high, about 2 in. square at the base and ¾ in. at the apex. The apex was placed next to the pipe while the mesh rested on the base of the pyramid. These blocks were hand cast by a man operating a hand mold that made 4 blocks at a time. In 9 hours it was possible to turn out between 2,500 and 3,000 such blocks. As blocks were placed, the edges of the reinforcing fabric properly lapped were tied together with soft iron wire.

Concreting

Forms were then set up and filled with a rather wet concrete mixture consisting of 1 part cement, 2½ parts sand and 1 part crushed rock, graded up to ¾ in. Concrete was hand mixed. When depositing, it was worked to place and properly consolidated by puddling with a small rod and by constant



VIEW OF FORMS AND REINFORCING USED IN CONCRETE COVERING AN OLD STEEL WATER PIPE.

tapping on the sides of forms. The following day forms were removed and the concrete given a coat of neat cement paint. Following this it was covered with dirt and kept wet for ten days to insure thorough and uniform hardening.

A gang of 12 on this work proved that 100 ft. of 24-in., or 130 ft. of 18-in. or 160 ft. of 14-in. pipe could be covered as described in a day of 9 hours. At the time this work was done, labor cost from $2.25 to $2.50 per day. Cement cost $2.30 per barrel on the track, sand $1.50 per cubic yard, broken stone 80 cts. per ton plus hauling. The wire mesh used on this work cost 6½ cts. for No. 10 and 12 wire and 4 cts. for No. 12 and 14 wire per square foot, woven in 1 x 2-in. mesh. The heavier wire in each case ran longitudinally and the light wire laterally.

Cost

The cost of the work, exclusive of excavation, was $1.14 per running foot for covering 24-in. pipe. This cost compares with two alternatives that were offered—replacement of the old pipe line by using 12-gauge steel at $1.36½ per foot, exclusive of hauling, and $1.50 per foot for precast reinforced concrete pipe, exclusive of hauling. The cast-in-place work, therefore, showed a desirable economy.

Sewer Design and Construction

Using Air Compressor on Varied Trench Work in New York City

By C. L. Edholm, Engineer, 68 West Ninety-seventh Street, New York City

Getting under the skin of Manhattan is a difficult job, as the digger of trenches in the city streets has learned. The average man knows it, too, for he is the one who is forced to pick his way around excavations where an underground structure is being installed. The contractor knows it best of all, for his profits depend upon the speed and thoroughness with which he can pierce the tough skin of the city and patch it up again.

Increasing Use of Air Compressors

So it is a matter of interest to all parties concerned to observe the increasing use of the air compressor in trench work, which lightens the labor, cuts the cost and shortens the time of excavations in the streets. Not only is the work completed with much greater speed, thus lessening the inconvenience to the general public, but the cost of doing the work is enormously reduced, cut to one-fifth, or even one-seventh, of the previous expense of trenching.

Cutting Asphalt Pavement

From the very first step the air compressor is in evidence. The asphalt pavement is cut along the lines of the proposed ditch by hammer drills, and the concrete base upon which it rests is handled by the same rapid fire implement. Before the portable air compressor had come into common use the method employed was exceedingly slow and laborious: One man would hold the long, pointed chisel known as the "bull point" against the tough surface, while two big-muscled laborers would drive it in with sledge-hammer blows.

Now a man with a Sullivan hammer drill speedily tears off the asphalt surface, while a second driller follows a few yards after him and attacks the tough concrete, which a shovel man throws out of the ditch. The foundation may run

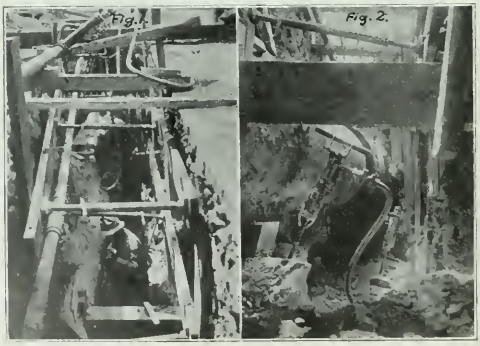


FIG. 1—DRILLING ROCK FOR BLASTING, BROADWAY, NEW YORK. FIG. 2—JACKHAMER DRILLS IN BOTTOM OF SUBWAY TRENCH IN BROADWAY.

from 4 in. to 1 ft. in depth, and for a small subway that may mean one-half of the depth in the latter case.

The cost of this operation is cut to one-third or one-fifth by the present method, hence it pays to put air compressors on the job for breaking the pavement, even though the soil underneath requires no drilling.

Using the Jackhamer

In case rock is encountered below the concrete, the "jackhamer" is put to use, at an average saving over hand-drilling operations of 86 per cent. With this apparatus, small and easily handled with a tripod, a hole may be run from 6 in. to

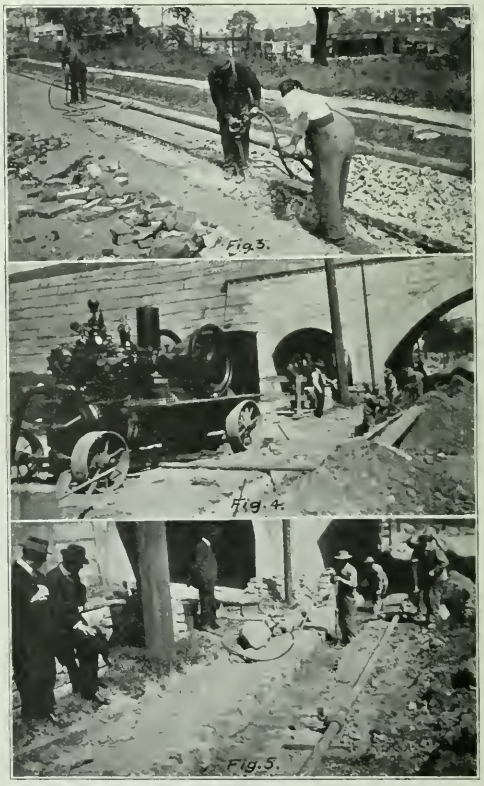


FIG. 3—SULLIVAN HAMMER DRILLS CUTTING ASPHALT BLOCK PAVEMENTS AND CONCRETE BASE. FIG. 4—CHICAGO COMPRESSOR SUPPLYING PNEUMATIC RAMMERS IN TRENCH. FIG. 5—INGERSOLL-RAND PNEUMATIC TAMPING MACHINE RAMMING BACKFILL IN TRENCH.

6 ft. and of a diameter ranging from 1 1-16 in. to 1¾ in. Cutting the cost of drill holes for blasting to one-seventh is a great saving, and when one adds the saving of overhead charges that result from shortening any job of contracting, such as salaries of engineers and executives, clerks, watchmen, etc., the results are even more impressive. The saving to those who use the streets, merchants who deliver goods, freight

handlers who do heavy hauling and the owners of other vehicles for business use or pleasure, can only be guessed at, but undoubtedly every day saved in street excavation is big money saved for the public that uses the thoroughfare.

The last step of trench work is the filling of the excavation and tamping the soil preparatory to repaving. This is often an unreasonably slow operation, though under the old method of tamping by hand there was some ground for delay, as it was useless to pave upon soil that was not thoroughly settled. The present method makes use of a pneumatic tamper that does the work in a hurry, but does it right.

The Crown Floor Rammer

For this purpose the machine known as the "crown floor rammer" is utilized, an application of compressed air that was devised for use in foundries, where it was employed in ramming sand in the casting room. Their availability for tamping was discovered and made use of, so that today from start to finish the street excavation employs the air compressor.

The development of the air compressor in the last few years has been rapid, and yet it is still being perfected, the present demand being for a machine which is light and easily transported, yet capable of supplying the 50 to 75 cu. ft. of free air per minute required to run a jackhamer. The gasoline-driven compressor seems to be the most desirable for trenching on any job that requires shifting of the machine at intervals. Hand drilling and steam drilling for trench work are practically obsolete, except where a steam line can easily be taken off of a steam boiler on a trenching machine. For jobs on which the machinery can remain in one position for some time the electric-driven compressor is economical and efficient.

Gas-Driven Portable Compressor

The Empire City Subway Company, Ltd., which handles subway contracts for the New York Telephone Company, makes use of four of these gas-driven portable compressors. They range in size from a 27 h. p. machine, with a capacity of 150 cu. ft. of free air per minute, to a very small one of from 3½ to 5 h. p. of 24 cu. ft. per minute capacity. The latter is easily moved by two men, weighs but 1,200 lbs., and like the larger sizes is mounted on wheels for easy transportation.

The photographs herewith show the various tasks of the hammer drills, jackhamers and tamping machines on the streets of New York or beneath them, and suggest that without their aid the big problem of getting under the skin of Manhattan would be almost impossible of solution.

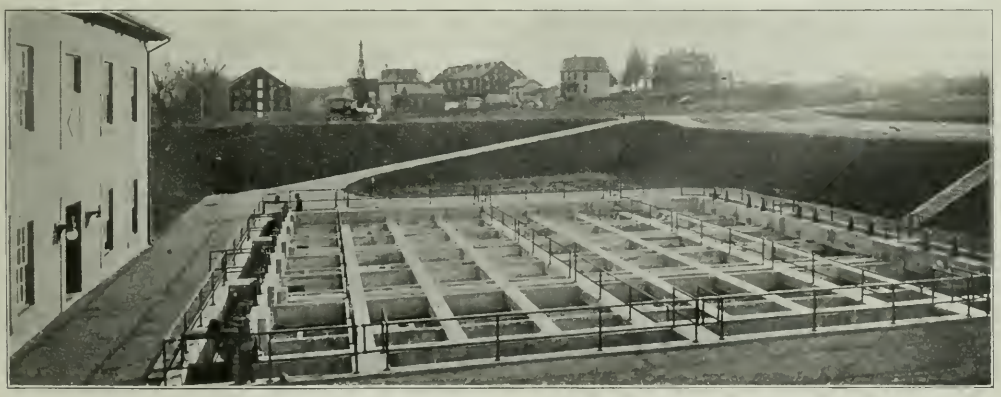
Water Purification and Sewage Treatment

Making Sure of Proper Operating Methods at York, Pa., Sewage Treatment Plant

The neglect of sewage treatment plants is an old as well as a sad story. Next to downright neglect comes faulty operating methods. If a plant has any care at all it can be made to work better if the operator is properly instructed by the designer. The present article goes into detail to show how a very full set of instructions was prepared to govern the operation of the sewage treatment plant at York, Pa. In these instructions the details are listed with more than usual fullness. The reader should not infer from our introductory remarks that the York plant was ever either neglected or poorly operated. It is a notorious fact, however, that most sewage treatment plants are either neglected or poorly operated, and this article is intended to emphasize the extreme desirability of having competent and well instructed sewage works operators in charge of treatment plants. Of course, this is a big plant and the instructions are extensive. However, even a simple set of instructions will prove invaluable to the average operator of a small plant and will insure better operation than where the designer forgets the plant and lets the operator struggle along unaided.

Brief Description of Plant

The York sewage disposal works consist of a coarse screen, 3 settling tanks of the Imhoff type, 4 sludge drying beds, a pumping station having a total capacity of 25,000,000 gals. per day and apparatus for automatically measuring the flow of sewage and disinfecting the tank effluent by the application of liquid chlorine. The works were designed to serve a population of 30,000, with an average dry weather flow of 4,500,000



VIEW OF SEWAGE DISPOSAL PLANT AT YORK, PA.

gal. per 24 hours, and double this amount for short periods during times of storm.

Screen Chamber and Venturi Meter

Sewage enters the screen chamber through a 60-in. sewer and passes through inclined bar screens with openings 2½ in. between the bars. The large matters in the sewage, consisting chiefly of rags, are caught on this screen, while the liquid and smaller matters pass on to the settling tanks. The screen is cleaned by rakes once a week and the accumulation taken from the screen, usually about a bucket full, is buried.

After passing through the screen, the sewage goes through a Venturi meter to the settling tanks. As the sewage passes through the Venturi meter the difference in head actuates an automatic recording device in the pumping station. This automatic recorder indicates the rate of flow in million gallons per 24 hours, gives a record to the total amount which has passed through the meter and also gives a chart of each day's flow.

A circular concrete sewer parallels the Venturi meter and conveys sewage from the screen chamber to the settling tanks during times when the Venturi meter may be temporarily out of service for cleaning or repairs.

The flow of sewage from the screen chamber to either the meter or the bypass is controlled by sluice gates in the screen chamber.

Settling Tanks

After passing through the Venturi meter, the sewage enters the channels around the tanks. The three settling tanks are built together with an outside channel extending around the four sides of the tanks. The three tanks and outside channel cover an area of 83 ft. square. Each settling tank is 72 ft. long by 23 ft. wide with a total depth of 27½ ft. Each tank is divided into two settling compartments each 8 ft. wide and 14 ft. deep extending the full length of the tanks. The sides and bottom of these settling compartments are made of hanging baffles of cement plaster on metal lath 2 in. thick. These baffles overlap at the bottom so as to form a slot 9 in. wide extending the length of the tanks. The overlap forms a gas trap so that no gases can pass upward into the settling compartments.

Below the settling compartments are the sludge digestion chambers. There are 3 sludge chambers in each tank. These chambers are 23 ft. square with sloping, hopper-shaped bottoms and have a depth below the settling compartments of 11 ft. Openings between the tank walls and the sides of the settling compartments lead directly to the sludge chambers, and provide for the release of gases generated by the decomposing sludge. The sewage upon entering the channels around the tanks is deflected in either direction by means of sliding gates. The flow from the channels into the tanks is controlled by means of swinging gates which deflect the flow into any tank. The sewage passes through the settling compartments, where, due to decreased velocity, the suspended matters in the sewage settle to the sloping bottoms of the settling compartments and slide through the slot into the sludge digestion chambers.

The liquid passes out of the tanks into the channel at the opposite end of the tanks and then through the lower part of the pumping station and to the Codorus creek. The flow of sewage through the tanks is reversed about every two weeks.

Sludge is deposited in greater quantities near the inlet ends of the tanks and by regularly reversing the direction of flow, the depth of deposited sludge is kept constant in the different sludge chambers.

The detention period of the sewage passing through the tanks is about two hours, so that the liquid leaves the tanks practically as fresh as when it enters them, but has in the meantime been freed of the floating and suspended matter it contained. The sewage on leaving the tanks is slightly turbid.

The sludge which has settled to the lower compartments is allowed to remain there approximately six months, during which time it has been decomposed from unstable organic matter into a staple form. This decomposition of the sludge is brought about by certain bacteria which grow rapidly under such conditions and is attended by a rather violent ebullition of gas. The gases, however, are inodorous, being largely carbon dioxide and methane. They escape through the gas slots at the sides of the tanks. After being decomposed, small quantities of sludge are withdrawn from the tanks and forced by compressed air onto the sludge drying beds. When put on the beds the sludge has a slight odor of tar. It quickly dries to an inodorous mass resembling garden soil. Sludge is withdrawn from the tanks without any interruption of flow.

Disinfection

After leaving the tanks the liquid portion of the sewage passes into the lower part of the pumping station, where it is disinfected by the application of liquid chlorine.

SLUDGE BEDS, YORK, PA., SEWAGE DISPOSAL PLANT.

This chlorine, which is a gas, is received at the works in steel cylinders of about 100 lbs. capacity each. These cylinders are attached to the chlorine apparatus where the amount of chlorine applied to the sewage is controlled. After being set to apply a certain amount of chlorine per million gallons of sewage, the apparatus automatically feeds the gas at this rate. After passing the control valve the chlorine gas is mixed with water and this saturated solution is fed into the effluent as it enters the pumping station.

A detention period of about 15 to 20 minutes is provided in the wells of the pumping station, during which time the chlorine thoroughly mingles with the effluent.

At the present time between 80 per cent. and 90 per cent. of all bacteria are being destroyed.

Pumping Station

During times of low water in the creek the sewage passes through the pumping station and into the creek by gravity. During times of high water in the creek the sewage must be lifted and forced out against the back water from the creek.

The pumping station building is two stories high with the suction and discharge wells below the lower floor. It is 60 ft. long, 30 ft. wide and built of brick and concrete.

The main pumping units consist of 3 motor-driven centrifugal pumps, each capable of pumping 5,000,000 gal. per day. There is also a reserve pump capable of pumping 10,000,000 gal. per day. This reserve pump is operated by a 50 H. P. gasoline engine and is an emergency pump in case that electric power is not available at the station.

The pumps are all on the top floor of the pumping station so that the lift is all suction lift of about 23 ft. maximum. The pumps are primed by a vacuum system which exhausts the air from the pumps and pulls the water up into and above the pumps. With the exception of the gasoline driven units, the pumping machinery is almost wholly automatic in its action.

The vacuum pumps are so arranged that they will automatically maintain the required vacuum. If the vacuum falls

the pump automatically starts, stopping when the upper limit is reached. The same thing is true of the air compressor which supplies air for operating the sludge ejector and for starting the large gasoline engine.

The sewage pumps are controlled by float switches in the wells of the station. When the sewage reaches a certain level, one pump automatically starts. If the sewage flow is greater than the capacity of one pump and the sewage level continues to rise, a second pump is automatically started, and so on to the third. The pumps automatically stop in rotation as the level of the sewage falls.

On the lower floor of the pumping station is the office, the flow recording apparatus, the chlorine apparatus, the heating plant and toilet and washrooms.

Gauges on the upper floors give continuous charts of the height of sewage in the wells of the pumping station and of the water level in the creek.

Situated in a pit in the south end of the pumping station is the sludge ejector which lifts the decomposed sludge from the settling tanks and discharges it on the sludge drying beds.

GENERAL VIEW OF PUMPING MACHINERY, YORK, PA., SEWAGE DISPOSAL PLANT.

This ejector is operated by compressed air, and by setting the valves on the sludge, it is possible to pump sludge onto the drying beds or from one settling tank to another. The works are protected from high water by an earth dyke which is high enough to protect the works from floods such as that of 1884.

Samples and Tests

Samples of the sewage to show the amount of solids removed by the tanks are taken daily. These tests have shown a removal of from 90 per cent. to 100 per cent. of all matter capable of being settled out. Two sets of samples of sewage as it enters and leaves the settling tanks, of the sewage after being disinfected and creek water both above and below the outlet from the works are taken three times a week on alternate days.

One set of samples is kept at the plant and tested for putrescibility or putrefying action. These tests have invariably shown that the effluent of the works is more stable than the water in the creek. The other set is brought to the city laboratory at the city hall and the number of bacteria present is counted.

Complete records of all tests as well as of the sewage flow, height of water, amount of chlorine used, depth of sludge in the tanks and of all other operations of the plant are kept. Copies of these records are filed in the office and sent to the State Department of Health.

The plant has now been in continuous and successful operation for over a year, and no odors or objectionable features have ever been present.

Directions for Operating the York Sewage Treatment Works

Screen Chamber—Clean screens once a week. Record date of cleaning, amount of screenings, how disposed. Bury or burn screenings as soon as removed. Flush bottom of screen chamber as needed. There will probably be some heavy matter which will not be caught on the screen, but which may lodge back of the screen, and this should be flushed out before it has started to decompose. It is hard to tell just how often this flushing will be necessary, but a careful watch kept for these conditions will enable the operator to know when to flush.

Venturi Meter—Flush pressure chamber of meter and pressure pipes to pumping station twice a week. Close valves on lines leading to chlorine diaphram when flushing pressure pipes from pumping station. While flushing once a week has been sufficient up to the present time, to be on the safe side it is considered better to flush twice a week. If the valves on the lines leading from the meter pressure pipes to the chlorine controller are not closed when water is turned into the pressure pipes the chlorine diaphram will receive the full water pressure and is liable to be broken.

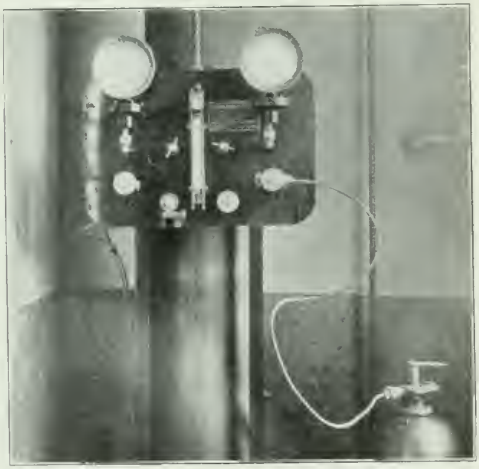
Venturi Meter By-Pass—Use only when necessary to clean body of meter tube. The by-pass should only be used when it becomes necessary to close off the Venturi meter for cleaning or repairs. After the by-pass is used, the gate in the screen chamber should be closed and a stream of water introduced at the manhole back of the gate in the screen chamber, and the by-pass flushed clean before the stop planks at the entrance to the tanks are put in place.

Channels Around Tanks—Keep channels clean at all times. Flush out deposits once a day in winter and twice a day in summer. Clean channels thoroughly before reversing flow in tanks. Deposits are most likely to occur in the channels at the inlet to the tanks and between the last swinging gate and the stop planks. Care must be taken to see that these deposits are washed into the tanks and are not allowed to get into the outlet channel and into the pumping station. Before reversing the flow through the tanks, be sure that the channel which is to become the outlet channel when flow is reversed is thoroughly cleaned and that the deposits are swept into the tanks. If this is not done the deposits in the channel will be washed into the pumping station when the flow is reversed. Deposits in channels and in pumping station tend to cause odors.

Settling Compartments in Tanks—Skim off oil, grease and floating matters once a day. Dispose of oil outside the tanks. Do not let oil from barrels get into the catch basins. Clean sides and bottoms of settling compartments once a week in winter and twice a week in summer. Clean slots once a week. Reverse flow in tanks once every two weeks. Remove all floating matter between scum boards and end of tanks before reversing flow. Break up ice which may form on tanks when about an inch thick or less. Keep sand or grit on hand for use on walks of tanks during cold weather. Reverse flow in tanks at time settling compartments are cleaned. In cleaning down the sides of the settling chambers the cleaner should be moved slowly and the deposits on the sides forced through the slot into the sludge chamber. This is especially necessary at the outlet end of the tanks so that the matters scraped from the walls are not stirred up and carried away into the outlet channel. See that every part of the tank is cleaned, for if deposits adhere to the sides and decompose, odors are sure to result. At times of reversing flow, clean down thoroughly all parts of the tanks between the scum boards and the end of the tank at the inlet end (or what will be the outlet end after flow is reversed). After the deposits which are stirred up in cleaning have settled, then reverse the flow. Most of the floating

matter on the tanks can be made to sink by sprinkling with water. Oil, however, must be skimmed off and removed from the tank.

Sludge Chambers—Measure and record depth of sludge once a week. Stir up sludge once a week with pressure water. Never let sludge get over 9 ft. deep as indicated by the tag on the measuring chain. Measure and record depth of sludge about 2 hours before and after removing sludge. Flush sludge pipes with pressure water after removing sludge. Remove sludge from tank No. 3 about May 1 and about every two months thereafter. About an hour before removing sludge, open valve B for a few minutes so as to loosen up the sludge around the sludge riser pipe. This should be done some time before sludge is drawn, so that the sludge has time to settle; otherwise partly digested sludge may be withdrawn to an objectionable extent. To remove the sludge, open the 8-in. valve at the sludge riser, the pressure of the water above will then force sludge into the pipes leading to the ejector in the pumping station. Sludge should be removed from one pocket of a tank at a time. The valve in the ejector pit must be set either to discharge sludge on to the drying beds or into another tank. If it is desired to discharge sludge into another



CHLORINE APPARATUS, YORK, PA., SEWAGE DISPOSAL PLANT.

tank, the 8-in. valve at the pocket into which sludge is to be discharged must also be opened. After a relatively small quantity of sludge is withdrawn the valve of that pocket is closed and sludge drawn from another pocket. After withdrawing sludge, the sludge pipes must be flushed. This can be done by opening valve C or by back-flushing from the air and water connections provided at the ejector manifold in the pumping station. In putting sludge into the sludge drying beds, do not use over about 50 lbs. of air pressure. In putting sludge into another tank instead of one of the sludge drying beds, do not use over 15 lbs. of air pressure and have the plugs at the top of the vertical sludge pipes secured in place. The water used in flushing should be discharged onto a section of the drying beds on which there is no sludge. The line leading to the beds may be back-flushed, if necessary, by putting water from a hose in the pipes at the beds. Watch must be kept at the sludge drying beds and if partly digested sludge appears, the valve leading to the bed must be closed at once. Partly digested sludge can be recognized by its grayish color, and by its foul odor. Digested sludge is brownish-black, with only a tarry or rubbery odor.

Gas Vents—Break up scum in gas vents daily. Record distance from top of scum to top of walls or "free board." Record appearance and odor of scum. If the floating sludge or scum which collects in the gas vents cannot be broken up by sprinkling with water, it will have to be broken up with a pole or otherwise. Large quantities of scum must not be allowed to collect in the gas vents.

Sludge Drying Beds—Put sand on beds before putting on sludge. Put sludge on beds preferably to a depth of about 6 to 8 in.; never over 12 in. Make the necessary measurements and records called for by operating sheets. Before applying sludge to the drying beds a thin layer (about ⅛ in.) of sand or very fine stone should be put on the beds. This will prevent the sludge from working down into the stone on the beds. When the dry sludge is removed from the beds much of the thin layer of sand will come off with the sludge so that the sand ought to be removed each time sludge is put on the beds. Never put partly digested sludge on the drying beds, but bury it at once. Do not put freshly withdrawn sludge on top of sludge already on the beds, as it will not dry quickly. Do not remove from the drying beds sludge which is only partly dried. Wet or freezing weather interferes with the drying of sludge so that it is better not to withdraw sludge during wet or freezing weather. Measurements should be made as soon as the sludge is placed on the beds and just before removal from the beds. Weather conditions during the time sludge remains on the drying beds should be carefully recorded.

Acknowledgement

The works here described were designed by George W. Fuller, Consulting Engineer, 170 Broadway, New York city. The instructions for operating the plant were prepared by George W. Fuller and J. K. Giesey, special assistant city engineer. We are indebted to Mr. Fuller for the views shown herewith.

State Highway Officials Favor Use of Motor Trucks to Relieve Rail Shortage

To consider auxiliary shipping measures of war products in the event of a possible car shortage, a meeting, called by R. C. Hargreaves, temporarily associated with a committee of the council of national defense, was held at the Detroit Board of Commerce recently.

Those present represented the state highways departments of the states of Indiana, Ohio, Michigan, Penusylvania, New York, Virginia, as well as district engineers from the office of Director of Public Roads Logan F. Page, and the United States Army Engineer Corps, R. D. Chapin, chairman good roads committee, National Automobile Chamber of Commerce; William E. Metzger, chairman of the good roads committee, Detroit Board of Commerce; A. A. Templeton, president of the Board of Commerce; Captain Galbraith and William Inglis, with whom R. C. Hargreaves is associated in the present emergency war work.

A comprehensive plan of assembling supplies at important industrial centers was outlined, and the routes over which such products would travel by motor trucks destined for port terminals was discussed in detail. A typical object lesson of unpreparedness was cited in the Detroit-Toledo road, where a stretch nine and a quarter miles in length still remains impassable for heavy traffic.

What this particular stretch might mean in loss of Michigan blood in foreign fields was vividly described by Mr. Hargreaves. Great enthusiasm was aroused through a wire received from Governor Sleeper, pledging his support in the effort to immediately put this road in passable shape.

Refuse Collection and Disposal

Contract Plans and Specifications for Obtaining Refuse Incineration Works on the Most Economical Basis

By Rudolph Hering, D. Sc., Consulting Engineer, 170 Broadway, New York City

A satisfactory solution of the problem of City Refuse Disposal can result only when both sanitary and financial solutions are satisfactory and when the construction, management and operation of the works are sufficiently simple to be controlled with ease and reliability. We have had, and still have, some cases where both or either of the sanitary and financial solutions are not satisfactory, except under restrictions which are too complex for ordinary application, said Dr. Hering in an address to the American Public Health Association, here abstracted by him for Municipal Engineering:

Interrelation of Plant Design and Operation and Refuse Collection

It is worth while to examine the efficiency and economy of sanitary refuse disposal works from this point of view. To do this, the inquiry should be made along three lines: First, the design and construction of the disposal works themselves; secondly, their operation, and, thirdly, the collection of the refuse in relation to its delivery at the points of disposal.

There is an intimate connection and interrelation between these parts of the subject. Any one of them may itself be satisfactory, yet at the same time one or both of the others may not. There have been cases where a cheaper cost of collection has required a more expensive disposal. There have been others where a cheaper disposal justified a more complex or more expensive operation or collection.

Assuming, which is true, that there are a number of ways in which the different parts of city refuse can be disposed of in an unobjectionable and a sanitary manner, it was customary for a long while to recommend the cheapest disposal, be it dumping, burial, incineration or reduction, wholly irrespective of the cost of collection and operation.

It was later found that the cheapest disposal works were not always the cheapest to operate. Some systems of incineration and of reduction, costing less for installation, were more expensive in operation. The unfortunate result of this practice has been that, to reduce the greater annual expense of operating a cheaper first-cost plant, its sanitary conditions were neglected.

It was also found that a greater annual cost of the disposal works could be more than balanced by a smaller cost of collecting and delivering the refuse to them.

The result of these facts shows that a city, in order to ascertain the most satisfactory sanitary solution of its refuse disposal problem, should not ignore the interrelation of the three above mentioned integral parts. It should find the least combined annual cost of all three of them, under conditions requiring all parts to give inoffensive results.

After stating this general conclusion regarding the city refuse problem, it is the author's object to consider in detail one kind of final disposal works, namely, incineration, and to call attention specifically to some feature of their contract plans and specifications that have recently enforced attention.

General Consideration Affecting Bids

It is important, in view of what has been said, that bids should be asked for in a way to get the most efficient and most economical system, beginning at the point of collection and ending at the points of final disposal, under the specific conditions existing in the city. It is essential, first, that a decision as to the general solution of its problem should be reached after sufficient preliminary engineering studies have been made; and, secondly, that specifications and general plans be prepared which will secure the most economical of perhaps several efficient projects.

In preparing specifications, a complex phase is sometimes introduced by providing not only for the incinerators with their machinery, but also for the buildings to house them. The first is the work of an engineer, the second that of an architect. Further, it is difficult to predict all the conditions that will obtain after the plant has been turned over for operation. It may be well to keep the details of utilizing the by-products, namely, steam and ashes, in abeyance until a practical demonstration has been made of the plant under the local working conditions. It may be questionable whether it is best to use the steam in connection with the water works, the sewage or other pumps, the manufacture of ice or other products, etc. As the refuse itself varies its fuel value also varies, and the quality of the ashes or clinker may differ materially.

Local preferences may vary as to the amount of money at the outset should be spent for the external appearance of the buildings and of their surroundings. It might be arranged to have the contractors bid for the furnaces and machinery alone, from which bids the city could select the type of furnace desired. Then an architect could plan the buildings and surroundings appropriately. Or, the contractors could include the price for the most simple building to house the machinery; or, they could state a certain percentage price at which they would furnish the material and labor for, and superintend the erection of, the buildings as they would be designed and specified by the city.

Let us now assume that the incineration of all, or of a part of the total refuse is required, that the site for an incinerator has been selected, its desired capacity fixed and that the general type and arrangement of the plant have been determined. The city should then prepare a general layout, suiting the property secured, and designate as much detail as it desires regarding the buildings, the furnaces and machinery, specify the quality of materials and construction, the arrangements demanded for operating the plant and the basis upon which bids will be received to secure the lowest continuous operating cost.

Getting Bids

After such a preparation, competitive bids can be obtained on a uniform and safe basis. Unless such definite conditions as these are stated, some bids might be based on inferior material and workmanship, as well as on undesirable types of furnaces and machinery, that would eventually produce unsatisfactory results, and, therefore, not offer fairly comparable bids, should other and higher bids have been based on better machinery, better material and more careful construction.

In order to facilitate a fair comparison of the bids the city should specify all essential requirements, based on the results of the engineer's study, as mentioned above, but including also the amount and kind of refuse, the time of its delivery, the size of chimney required, the floor spaces, the desired general handling of delivery wagons, the desired way of removing the ashes and other similar but essential details.

Unless bids are asked for in this manner, there may be added to the numerous instances already on record more such cases where the sanitary results are unsatisfactory and where the operating costs are unexpectedly high, due to inefficient handling of the refuse, difficulties in removing clinker, congested furnace room, chimneys of insufficient draught and for other reasons.

Plans

The city plans should show the site with the elevation of the ground, the borings made to firm foundations and the streets and railroads adjoining or near the site. It should also indicate the approximate location, size and shape of the furnace building, and of its accessories, so far as the city wishes to indicate them.

The bidder should submit plans of the furnaces, their appurtenances and the entire equipment of the plant asked for, so that the city may have the advantage of a lower price for using stock patterns. These plans should be prepared in sufficient detail, so that an expert engineer for the city can fully comprehend every essential part, as related to the design and construction of the building, the approaches, the arrangement, design, construction and operation of the furnaces and of the main accessories and appurtenances, so far as the city has left the choice to the bidder.

Specifications

The city should specify all matters that are necessary to protect its interests in the general design and construction of the plant and to present all required conditions as to labor and materials as fully and as clearly as possible, so that the bidders are not left in ignorance on any essential matter that is required and can make a fair bid on a uniform basis with other bidders. In order to get a low bid from the best contractors, the city should assume all chances over which the contractor can have no control.

All terms should be clearly defined to avoid misunderstandings. Whatever the city will furnish to, or demand of, the contractor, in the way of supervision, inspection, labor and material, must also be clearly stated. The composition of the garbage as to combustible, ashes and water should be given within reasonable and safe limits. If the city has decided upon any details in the arrangement of the plant and handling of the refuse material, the ventilation of the building or any arrangement for preheating, draught air, for forced draught, steam generation, etc., these should all be clearly stated.

On the other hand, the bidder should submit specifications describing in full detail the construction of the furnaces and their appurtenances and the entire equipment proposed by him within the city's specifications, so that the efficiency and durability of the plant can be fully comprehended by the city's expert engineer.

The bidder should specify the power required to operate his proposed furnaces at their maximum capacity, the man-hours of the different kinds of labor required per ton of refuse to be incinerated and the average rate of evaporation in the proposed boilers, from and at 212 degrees Fahrenheit, per pound of refuse consumed and having a composition specified by the city. He should also furnish evidence of previous and similar work he has done.

This information should be sufficient to determine during a test to be prescribed by the city, not only the efficiency of the plant, but also the annual cost of incineration per ton of refuse.

Guarantees

It is proper when a competent expert contractor submits his own plans and specifications and bases a bid thereon that he should be willing to guarantee certain results. Some of the guarantees that would be required on the part of the city cannot always be stated with such definiteness that they are entirely independent of judgment. The city engineer, or some special expert in this matter, is, therefore, usually given the power to use his judgment in the interpretation of such guarantees. Some specifications have statements in a form, either too definite or not definite enough, with the expectation that, as the courts have frequently ruled, a reasonable interpretation could and would be made.

A few recent court cases have shown that judgments have varied substantially. It is, therefore, necessary that the specifications assist our judgment as much as possible, by stating in such cases, rather an approximation, than an absolutely definite result, which approximation is within the limits of practical experience in the art.

Specific Guarantees

It may be well to refer specifically to some of the guarantees heretofore given for a refuse incinerator:

Nuisance

1. No nuisance shall be created in the normal operation of the plant.

It is hard to define the word "nuisance" outside of personal judgment. Therefore, it is better to specify an odor, offensive to the average person, and a disorderly scattering of garbage and rubbish outside of the intended areas or receptacles, which is offensive to the average eye, should be considered a nuisance.

The term "normal operation" has been liable to confusion. This normal operation may refer to a test period which may be one day or thirty days, or it may refer to a whole season. A short test is best to ascertain efficiency and freedom from some kinds of offense, and a long test to ascertain endurance and freedom from other kinds of offense.

Temperature During Test

2. During the prescribed test the temperatures in the combustion chambers should not fall below 1,250 degrees Fahrenheit more than three minutes in any one hour, and that a continuous record shall show an average temperature of at least 1,400 degrees Fahrenheit.

This is an improved specification over an earlier one, that at no time during a test the temperature should fall below the above minimum. Yet it should be evident to a practical engineer that a drop of temperature for even four or five minutes in one hour would be due to a matter of temporary operation, possibly to new and not sufficiently experienced men, and not due to the design or construction of the plant.

Odors, etc., From Chimney

3. No odors, obnoxious gases, smoke or dust shall be emitted from the top of the chimney.

This specification, when strictly interpreted, is too definite as regards the top of the chimney, smoke and dust, and it is too indefinite as regards odors and obnoxious gases. A reasonable interpretation as well as the evident intention should be that it matters not what escaped at the top of the chimney; it is important that no solid or gaseous materials descending to inhabited buildings or upon the ground of the neighborhood should be objectionable. As it is impossible to have no dust whatever, nor any fine particles of smoke escape from the chimney, it has been proposed to substitute a specification that no dust particles shall escape from the chimney that cannot be settled at a velocity of 5 ft. per second. This would insure the settling of whatever dust would be objectionable before it reaches the top of the chimney. Whatever dust particles would then escape are incinerated organic and mineral matter, and would certainly not be any more objectionable than the ordinary dust raised from the surface of any average street by an ordinary breeze.

Furnace Residue

4. The residue from the furnace shall be thoroughly burned and free from organic matter.

It has accordingly been interpreted that no organic matter,

not even carbon particles, should be contained in the ashes. This would clearly be an unreasonable and unintended view. The first object of this particular specification should be to secure a furnace which, under proper operation, will turn out a residue incapable of causing a nuisance, *i.e.*, a subsequent offense at any time. This result could be obtained if the residue were nothing but carbon, and also if but a small percentage of the residue, such as one or perhaps 2 per cent., is unburned organic matter. Due to the practical operation of charging, stoking and of drawing out the ashes it is impracticable to avoid some incompletely burned matter occasionally from passing down into the ash pit. As such an insignificant amount has never been considered objectionable in modern plants, even when the ash is used for making artificial stone, no efforts have been made to further reduce it, and should not be objected to by the courts.

To avoid an unreasonable interpretation in such a case it is better to place a limit to the amount of incompletely burned organic matter which may be contained in the ashes of an incinerator. But even such a limit might be open to misinterpretation, unless the condition of the organic matter is also stated. If it is "resistant" organic matter, like wood, straw, bone, hair, feathers, etc., a very large percentage, even in an unburned condition, would not produce any objectionable results. But if the matter were "non-resistant," like flesh, or some vegetable pulp, perhaps partly putrified, a very small percentage might be offensive near by. Fortunately, in any refuse incinerator, that here deserves consideration, the non-resistant organic matter, when contained in mixed refuse, generally soon disappears by losing its moisture through absorption and evaporation. A dead mouse covered an inch or two with powered charcoal or fine ashes dessicates and spreads no odors.

Other Usual Guarantees

There are other usual guarantees which can be and have been quite definitely stated. Such are a statement of the least number of man-hours of labor per ton of refuse incinerated, computed according to a definite schedule, the least evaporation in the boilers under given conditions and a statement that the various parts of the incinerators must be so arranged that any one unit may be shut down to remove ashes and dust or to make minor repairs without disturbing the incineration process in any other unit.

Tests

In order to ascertain whether a plant is capable or not of fulfilling the requirements of a contract it is necessary to make a suitable test. For this purpose the city must provide sufficient refuse of the composition stated in the request for bids, and upon which the bid was originally based. The contractor must put the furnaces and their appurtenances into a working condition before the tests are begun and the city must designate a fixed period and time for the test.

It is important also to ascertain the amount of combustible and of free water contained in the refuse just before the material is dumped into the furnaces, and the specifications should fix the approximate limits between which the amounts may vary.

The city and contractor should jointly select the men required for operating the plant during the test. This should be made under the full direction of the contractor and in the presence of a city representative. The preliminaries of the test being thus completed, the fulfillment of each and all of the guarantees is then ascertained.

Conclusions

When disagreements exist between a city and a contractor, and as the controversial questions depend usually upon special knowledge and experience, it seems better to select, if possible, a single intelligent arbitrator, having had direct and sufficient experience with the particular subject in question, than to select two or possibly three intelligent persons, one or two of whom may be obliged to resort partially to an opinion which may be based upon a short or no actual experience.

The lowest bid will be that which provides a furnace and appurtenances, the operation of which under guaranteed conditions requires the least total cost per annum. This cost would be made up: First, of the interest charges on the construction expenses, the annual depreciation and all other fixed charges; and, secondly, of the net cost of operating the works of a stated capacity test period, reduced to one year, and which would consist of the required labor, machinery, tools, power, light, heat, repairs and the maintenance of buildings, grounds and office. The lowest combined annual costs will indicate the lowest bid, and, therefore, the most economical plant for the city.

In closing it may be well to revert to what was intimated at the outset, concerning the dangerous economical mistake for a city to consider only one part instead of all three integral parts of the problem.

Bridges and Buildings

Pennsylvania Specifications for Culverts and Short-Span Concrete Bridges

The essential clauses of the Pennsylvania state highway department specifications for culverts and short-span concrete bridges, recently adopted, are here given.

Foundations

The excavations for foundations shall be according to the dimensions shown on the plans and shall be carried to such depth as is necessary to secure good foundations free from all danger of damage from frost or scour. If such depth is greater than that shown on the plan, the additional concrete that may be required, shall be paid for at the price bid per cubic yard for additional concrete in foundations. Excavated material shall be deposited between the wingwalls or as the supervisors may direct.

The direction or length of wingwalls may be altered by the supervisors to suit special conditions at the site, and additional concrete that may be required, shall be paid for at the price bid for additional concrete required in the wingwalls.

If suitable foundation is found at less depth than that shown on the plan, or if the yardage of concrete is decreased by alteration of the wingwalls or by any other cause, the amount of such reduction, at the price bid per cubic yard, shall be deducted from the lump sum price.

Piling

Where satisfactory foundations cannot be obtained 4 ft. below the bed of the stream, piling may be used, and, unless otherwise shown on the plans, the spacing shall be 3 ft. center to center, and the piles shall be designed to take the full load. For safe loading, the following shall be used: Safe load in lbs. equals 2WH divided by S plus 1, where W equals weight

of hammer, H equals fall in ft. and S equals penetration in inches under last blow of hammer, but the maximum load on any single pile shall not exceed 20 tons.

After driving, the top of piles shall be trimmed of all broomed wood. The minimum projection into the concrete shall be 18 in. and the maximum 36 in. Before concreting, all earth loosened by driving shall be removed from around the piles.

All foundations shall be inspected by the supervisors before any concrete is placed in them.

Stone Masonry

Should it be desired to use stone masonry laid in cement mortar in the foundations, abutments and wingwalls, instead of concrete, the thickness of all such parts shall be made 10 per cent greater than those shown on plan.

Stone for masonry shall be clean, sound and durable. No stone shall be less than 6 in. in thickness unless otherwise permitted by the supervisors. No stone shall measure less than 12 in. in its least horizontal dimension, or less in a horizontal direction than its thickness. All mortar used shall be composed of one part Portland cement and three parts sand, and shall be mixed in such quantities as will insure its immediate use.

Stones shall be roughly squared on joints, beds and faces, and be laid on their natural beds so as to break joints and in full mortar beds. At least one-fifth of the stone in the face shall be headers, evenly distributed throughout the wall. All vertical spaces shall be flushed with mortar and then packed with spalls. No spalls will be allowed in the beds. Selected stone shall be used at all angles and shall be neatly pitched to true lines and laid on hammer dressed beds; draft lines may be required at the more prominent angles. Tops of wingwalls and parapets shall be capped with concrete not less than 6 ins. thick which shall project 1½ ins. over face of wall.

Forms

False work for slabs reinforced with bars or rails shall be unyielding and constructed with 1 in. of camber for every 10 ft. of span. For bridges constructed of I-beam stringers, the false work shall be supported from the beams.

All forms must fit tightly together to prevent leakage and be so braced that there will be no sagging or bulging under the weight of the concrete. Forms of all exposed surfaces shall be made of smooth lumber, surfaced to uniform thickness and be coated with oil or soap to prevent the concrete from adhering to them.

Forms on vertical surfaces that will be exposed to view in the finished work shall be removed in not less than 12 hours and not more than 48 hours, and the surface rubbed with clean water and a wooden float or carborundum block until it assumes a uniform sandy appearance. No painting or cement washing will be allowed.

Concrete

All concrete shall be most thoroughly mixed. If hand mixed, the sand and cement shall first be mixed dry, then water shall be added to make mortar, then the stone which has been previously wet shall be added and mixing shall continue until all particles of stone are completely covered with mortar. Concrete shall be placed in the forms immediately after mixing.

Concrete for the abutments and wingwalls shall contain sufficient water to cause it to flatten out and quake, but not to flow.

Concrete in which steel is embedded shall contain sufficient water to cause it to flow sluggishly.

Class "B" concrete, composed of 1 part by volume of Portland cement, 2½ parts of sand and 5 parts broken stone or gravel, shall be used for foundations, wingwalls and for abutments up to clearance line of bridge.

Class "A" concrete, composed of 1 part by volume of Portland cement, 2 parts of sand and 4 parts of broken stone or gravel, shall be used for floor slabs, beam casings and parapets.

Cement shall be true Portland cement of well-known brand, which shall be subject to the approval of the supervisors, and shall conform to the standard specifications of the American Society for Testing Materials, dated January, 1909. It shall be free from lumps, caking or watermarks, and when delivered on the work shall be in undamaged packages. It shall be stored on the work in such a manner as to be perfectly protected from wet or moisture.

All cement shall be subject to inspection and test, and cement not complying with the requirements will be rejected.

Water used in concrete shall be fresh and clean, and free from sewage or acids.

Concrete Materials

Sand shall be clean and hard grained, and shall be graded from fine to coarse, with no particles larger than ¼ in. in size. It shall be free from loam, silt or other foreign matter.

Gravel shall be composed of clean, hard particles, and be free from dirt or foreign matter of any description.

Stone shall be hard and durable, broken into approximately cubical particles, and be free from dirt or foreign matter of any description.

For Class "A" concrete: Gravel or broken stone shall be uniformly graded in size from ¼ to ¾ in.

For Class "B" concrete: Gravel or broken stone shall be uniformly graded in size from ¼ to ½ in.

No concrete shall be laid in freezing weather without the permission of the supervisors. For placing concrete in freezing weather the contractor shall establish a suitable plant for heating the water, sand and crushed rock or gravel. After placing the concrete the work must be thoroughly protected. Final approval of concrete masonry, laid in freezing weather, will not be given until inspected after continuous warm weather for at least 30 days.

Structural shapes shall be medium steel, manufactured by the open hearth process, and shall conform to the specifications of the American Railway Engineering Association, dated 1910.

Reinforcing

Reinforcing steel shall be medinm steel, manufactured by the open hearth process, and shall meet the requirements of the specifications adopted by the Association of American Steel Manufacturers for concrete reinforcing bars.

Reinforcing shall conform in size, form and position to the drawings, and shall be securely held in place during concreting. It shall be free from rust, dirt, grease and thick or loose mill scale.

Pipe railing shall be straight and true to the dimensions shown on the plans, and be erected in a most workmanlike manner.

Posts shall screw into fittings. Rails shall screw into end fittings and slide through intermediate fittings. The pipes shall be galvanized and all spots where galvanizing has been damaged shall be painted with aluminum paint.

Forms of concrete parapets or railing shall be constructed of desired lumber, and be erected with extreme care, and securely braced in place in order to insure the finished work being straight and true. Concrete shall be carefully spaded while being deposited. Special care shall be used in removing forms to avoid damaging the corners of the work. After removal of forms (in approximately 12 hours), the parapet shall be rubbed with a wooden float until it assumes a uniform sandy appearance, and all lines and panels are true and pleasing to the eye.

Design and Construction of Road Culverts and Bridges in Pettis County, Mo.

By T. O. Stanley, Highway Engineer, Pettis County, Sedalia, Mo.

During the last four years Pettis county, Missouri, has built more than 1,000 road culverts and nearly 100 bridges.

We build all our small culverts from 2 to 4 ft., of the box type. Over that, up to 10 ft., we build the arch type, if the

ELM BRANCH BRIDGE, PETTIS CO., MO.; SPAN, 30 FT.; ROADWAY, 18 FT.; COST, $569.

opening will permit; if not, we build the box and use additional reinforcement.

For reinforcing the small culverts on the top we use either an expanded metal, or woven wire, reinforcement. On the larger box culverts, in addition to woven wire, we use reinforcing bars sufficient to carry a live load equal to a 12-ton road roller. All culverts have a clear roadway of not less than 20 feet.

In bridges with 10 to 30 ft. clear spans we reinforce with steel I-beams. We arch between the beams, and spread one layer of woven wire on the top of the beams and build the concrete 2½ to 3 in. above the top of the beams. All bridges having a clear roadway of not less than 16 nor more than 20 ft., and built to carry a load equal to a 12-ton road roller the same as the culverts.

For bridges longer than 30 ft. we buy the fabricated steel and erect the bridges with concrete floors in about the same manner as in the smaller ones.

In all our work we buy the material, hire a reliable fore-

PEPPER BRIDGE, PETTIS CO., MO.; SPAN, 40 FT.; COST, $919.

man and erect the bridges by force account and eliminate the contractor's profits, as we think we can do it as well as he can, and at least save the overhead expenses.

As to the cost, that depends a great deal upon the distance the material has to be hauled, but our small culverts for the last three years have cost us approximately $50 each, while our larger ones have cost less than $100 each.

Our bridges of 10 ft. or more clear span have been costing us from $10 to $15 per lineal foot, including the foundation, and in some few instances, where the foundation was bad, they have cost as much as $20 per foot or a little more.

FROM WORKERS IN FIELD AND OFFICE

Experience With Frozen Water Meters in Terre Haute, Ind.

The Editor of MUNICIPAL ENGINEERING:

Sir—

Last winter was unusually cold with us, and the coldest weather came at a time when there was practically no snow on the ground. Our soil here is composed largely of sand and gravel, altho there is clay in a small portion of the city.

We have had meters set in outside boxes for many years, also in brick pits about 2 ft. 8 in. in diameter at the bottom and about 3 ft. deep, the meters being set on risers coming up from a depth of, say, 4 ft. 6 in. to 5 ft. We also have brick pits that are about the same diameter, but 4 ft. 6 in. to 5 ft. in depth, the meters being set at the bottom. Previous to last winter it is probably safe to say that we had never had a meter frozen in a brick pit either 3 ft. in depth or 5 ft. in depth.

Last winter we had about 7,000 meters, and probably 80 per cent. of these were outside installations. During the spring and summer of 1916—that is, previous to last winter—we set some 3,700 meters, most of them being installed in 15-in. tile, 3 ft. 6 in. long, on which was a cast-iron meter box cover 9 in. in depth, with a double lid or cover. As our time for installing most of these meters was very limited, some of them were not set in the center of the tile, and the result was that the risers were either touching the tile or very close to it.

Out of 7,000 meters in service, there were about 2 per cent. that were frozen. Among these were meters in 15-in. tile, in 18-in. tile, in the brick pits, and also in basements. In other words, the trouble was not confined to the meters that were set in 1916 nor to the meters in the 15-in. tile. We made an investigation to determine just where the meters were frozen, and from the information gathered we were not in position to point to any one particular style of setting where the proportion of meters frozen was greater than in the others; while there were more meters frozen in the 15-in. tile than in the brick pits and 18-in. tile, yet the proportion of the entire number of installations was not large. The most remarkable thing about it all was that meters were frozen in the brick pits, where they had never frozen before, altho we have had winters where the temperature was as low as it was last winter.

We have planned to give the places where the meters were frozen greater protection than they have had in the past, by installing in the 15-in. tile a cone-shaped tube that will extend from the yoke where the meter is set up to the inside lid of the box. The lower portion of the tube is the same diameter as the tile. These cones are made of three-ply roofing material and are substantial in character and construction. The object is to confine the warm air around the meter and prevent it coming in contact with the frozen ground which surrounds the upper portion of the tile.

It seems, from what I have been able to gather from the experience of others in this section of the country, that the atmospheric conditions last winter were unusual. This is

based on the information to the effect that there were more meters frozen in the various cities in this section during last winter than during any previous winter.

Yours very truly,

Dow R. Gwinn,

President and Manager, the Terre Haute Water Works Co.

October 6, 1917.

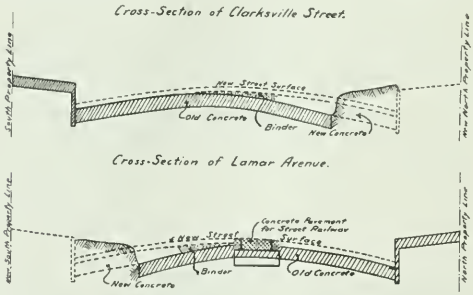
Using Old Concrete Base in New Pavement on Widened Streets

The Editor of Municipal Engineering:

Sir—

After the big fire in Paris, Texas, in the spring of 1916 the decision to widen the streets was reached. This required a change in crown and the removal of the old curbs and sidewalks.

A plan was devised by Hans Helland, Jr., then city engineer and now a captain in the engineering corps, United States army, to use the old concrete base where practicable. The new base was built over and on the old one which was first thoroughly cleaned. The new base was in no case less than



SECTIONS SHOWING USE OF OLD PAVEMENT BASE IN STREET WIDENING, PARIS, TEX.

3 in. thick. Where a less thickness than this was required to bring the old base up to the new grade, a binder was used of the sort commonly employed in asphalt pavement construction. The accompanying line cut shows the detail of the design.

Where the new grade cut the old base the entire base was removed and a new base of proper thickness built to the new grade. The street car track was not moved and is 3 ft. off center.

In widening our streets this scheme was used very satisfactorily and at a very small cost. The old topping was removed, the new concrete was placed so as to shift the crown, binder was used to keep from running concrete to feather edge. Then we placed the regular 2-in. bitulithic topping.

Yours very truly,

W. W. Whipkey,

Paris, Texas. City Engineer.

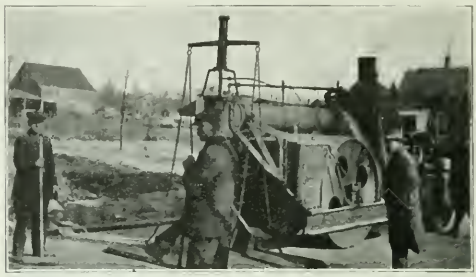
Method and Cost of Melting Snow With Asphalt Road Heater

The Editor of Municipal Engineering:

Sir—

The accompanying illustration shows the novel use of an asphalt road heater for melting snow in Glencoe, Ill. The heater was used by John A. McGarry & Co., of Chicago, Ill. It is an 8-ton Iroquois roller converted to the use described by the Barber Asphalt Company. The large flue was built on to carry the flue gases over the top and down to the 5 x 7 ft. hood.

A 4-inch snowfall covered up the last 5,400 sq. yds. of a 63,000 sq. yd. penetration job and the heater was used to melt



MELTING SNOW FROM UNFINISHED PAVEMENT WITH ASPHALT ROAD HEATER.

the snow from the 2 in. of top stone already spread on the concrete base. The cost of the snow removal was as follows:

Removal of heavy part of snow by hand	$17.00
Rent of heater, 4 days at $20 a day	80.00
Engineer at $6.25 per day, including carfare	26.00
Helper at $3.50 per day, including carfare	14.00
Pocahontas coal at $6.25 a ton, delivered, at ½ ton per day	12.50
Total cost	$149.50

This amounts to nearly 3 cts. per yard for melting alone. The actual pouring was also retarded about 50 per cent., as it had to be done close behind the heater, and the stone screening for the top also had to be heated. The writer is indebted to J. T. Child for the accompanying photographs and data.

Very truly yours,

Frank C. Perkins.

Buffalo, N. Y.

A Glimpse of Wooden Ship Construction

The Editor of Municipal Engineering:

Sir—

The accompanying view illustrates one of the famous Western Wooden Shipyards. The writer and his company have been connected with hoist equipment for a good many years in the East and came West with the idea that all equip-

VIEW OF WOODEN SHIPS UNDER CONSTRUCTION, SHOWING ALL-WOOD DERRICKS.

ment should be of fabricated steel. We studied the Western situation where the timber is of such large proportions that it enables one to use it in the manufacture of machinery and equipment instead of steel construction.

After studying the situation over here in the West, we have come to the conclusion that a wooden constructed traveling stiff leg derrick, properly constructed, can be built much cheaper and give better service than the steel derrick.

The derricks shown in the accompanying photograph are

placed between each two ships along a gage track of approximately 23 ft. The booms are provided 83 ft. in length, swinging entirely clear of all the scaffolding and original construction of the wooden ship.

On a platform mounted approximately 15 ft. above the derrick is a machine which operates the boom and hoist. The operator's point of operation is on a lever at the bottom of the machine, approximately 30 ft. above ground, from which point a full view can be obtained by the operator. Therefore, a signal man is not required. This also enables the wooden shipyards to construct the steel parts for the bed of timbers underneath the derrick.

This derrick is capable of traveling at a speed of approximately two miles per hour and handling loads up to 10 tons.

The old method of constructing wooden ships was to leave an opening in the front end of ship to pull all heavy timbers thru the bow by means of a donkey engine. This, we learn from observation and what literature we are able to obtain, is the common method used at the present time in a good many wooden shipyards; but after having equipped a number of the largest western shipyards with handling gear as required, we have found that the handling cost is reduced more than 50 per cent.

The Burbank Machinery Company, 3223 First avenue, South, Seattle, Wash., are the originators and designers of the derricks here described.

Very truly yours,

F. R. SCHOEN,

Seattle, Wash., Oct. 3, 1917.

Old Sand-filled Brick Pavement Relaid Monolithically

The Editor of MUNICIPAL ENGINEERING:

Sir—

About a year ago the city of Champaign, Ill., in an attempt to solve the problem of settlement, sand flows and the like relaid two short stretches of sand-filled brick pavement, using the old brick and a fresh concrete bed in place of the old sand cushion. The results obtained were so satisfactory that in relaying a badly settled and very rough pavement in one of the subways this fall the same scheme was used.

The old brick were first removed and thoroughly cleaned with wire brushes. The sand cushion was then removed and the old concrete base swept clean. A layer of concrete consisting of 1 part cement, 3 parts sand and 2 parts roofing

RELAYING OLD SAND FILLED BRICK PAVEMENT MONOLITHICALLY, CHAMPAIGN, ILL.

gravel was then spread and struck off to correct shape and elevation. Owing to the unevenness of the old base this layer varied from 2 to 6 in. in thickness. The old brick were immediately relaid on the soft concrete and rolled with an 800-lb. hand roller. The joints were then filled with a 1:1 grout in the usual manner, and the street blocked to traffic for two weeks to permit the cement to harden. The old brick were repressed block of good quality and but very little worn, although about 12 years old, and therefore were easily laid, and but few replacements with new brick were required.

The work was done by the regular street repair gang, with the equipment available at a cost of about 75 to 80 cts. per square yard. It is thought that with proper equipment and organization that a contractor could do this work at less cost to the city and still secure a reasonable profit. Nevertheless, the finished work is smooth and sightly, and replaces a very unsatisfactory pavement with structure fully as good as an entirely new pavement at about one-fourth the cost.

The work, both on the experimental sections and the subway, was planned and carried out by F. C. Lohmann, city engineer.

Very truly yours,

C. C. WILEY,

Instructor in Highway Engineering, University of Illinois.

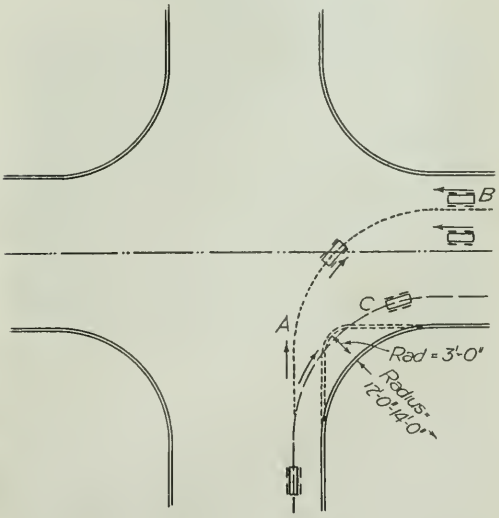
Urbana, Ill.

Lake Shore Drive (Chicago) Intersection Shows Advanced Practice in Curb Design

THE EDITOR OF MUNICIPAL ENGINEERING:

Sir—Street intersections are too commonly laid out with little thought of the change that has come about in vehicular traffic. Slightly rounded corners, once satisfactory, do not now make for convenience and safety and the practice is to be condemned. In the time of slow-moving, horse-drawn buggies and wagons of short wheel base they were satisfactory but they do not meet the needs of motor traffic.

The accompanying illustration shows the intersection of Lake Shore drive and Division street, Chicago, where the original 1½-ft. radius curb has been replaced by one of about 14-ft. radius. The old curb had not yet been removed. The distance



SUGGESTED INCREASE OF RADIUS OF CURB AT STREET INTERSECTIONS.

from the old corner to the new is 7 ft. on one corner and on the other 5 ft.

Vehicles turning into Division street had been forced to swing out into the center of the street or beyond, while the new curb permits a vehicle to make the turn with only slight speed reduction and without passing over the center line of the street. The diagram shows this clearly. Except at extremely low speed, a vehicle cannot avoid crossing the center of the

street in making the turn in the case of the old curb, while the long radius of the new curb permits it to keep to the right, in accordance with traffic rules.

Long radius curbs involve no construction difficulties. There can be no opposition to their adoption for all new work and a change of practice is imperatively needed where one or both of the intersecting streets have much swift-moving motor traffic. But the change should not be confined to new work. In every city there exist many dangerous intersections with boulevards or narrow streets where it would be in the interest of the city to reconstruct curbs in order to promote safety and to prevent delay and congestion.

Very truly yours,

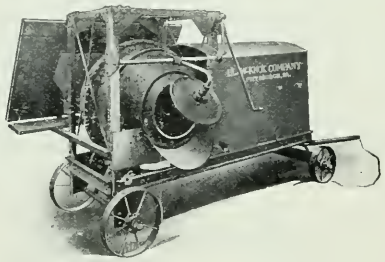
B. F. Affleck,
President Universal Portland Cement Co.

Chicago, September 8, 1917.

Plant Units and Lay Outs

A New 10-cubic-foot Concrete Mixer

The Blaw-Ransemixer here illustrated has full 10 cu. ft. capacity. The mixing is quick, due to the use of practically straight blades. These mixers have been in successful operation for over a year. The horsepower required to run the low charge type is 4 and that for the power loader is 6. The



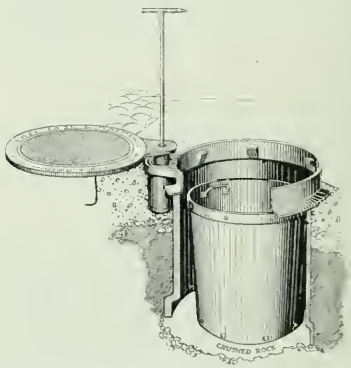
THE 10 CU. FT. BLAW-RANSOMIXER.

frame is of steel, with sills of 4 x 6¼-lb. channels, strongly braced. The overframe is of 3 x 3 x 3-16-in. angles, well gusseted and braced in both directions. The drum heads form a wide angle with the shell. The blades are straight and undercut in the direction of revolution, and are so set that the discharge from one blade falls on the back of the following blade, thus setting up a scouring action which keeps the mixer clean.

A Pivot Lock Cover for Sewers and Street Sweeping Receptacles

The "Ransenhousen Pivot Lock" cover, here illustrated, makes possible the prompt, economical and sanitary disposal of street sweepings during the daily process of cleaning the streets. The object of this device is to provide a place for the empty and full cans when not in use. These receptacles are flyproof and windproof and can be set into the sidewalk or street. They are protected by a locked cover which does away with all danger of liability from accidents to pedestrians. In practice these receptacles are evenly distributed throughout the beat of the sweeper and when he starts work in the morning he finds an empty can in each receptacle. He places one on his push cart and is ready to start cleaning up. After filling the first can he goes to the nearest receptacle, opens it with his key wrench and dumps his full can into the empty can that the receptacle contained, closses the receptacle cover, hangs his key wrench on his cart and goes on with his work without any waste of time. The time he saves in handling filled cans by this method enables him to clean a larger area.

At night a pick-up wagon or truck equipped with a swinging arm and a hoist comes around and backs up to the curb. The hoist is equipped with bale hooks, which are hooked to two bales on the inside of the cans. The cans are hauled out and placed on the truck and carted off to the dump, emptied and brought back and replaced in the receptacles for the push cart man or sweeper to use the next morning. The cans



PIVOT LOCK COVER AND SIDEWALK RECEPTACLE FOR STREET SWEEPING CANS.

are at all times protected from battering and should last much longer than under ordinary conditions.

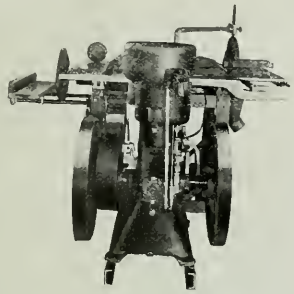
The "Ransenhousen Pivot Lock" cover, which is manufactured and marketed by the East Iron and Machine Company, Lima, Ohio, is also successfully employed on sewer manholes and wherever cover plates are used for any purpose.

A Portable Gasoline Sawing Outfit

Portable gasoline sawing outfits have long been in favor with contractors, especially where a large quantity of lumber is to be cut up for use in concrete forms. On the cantonment construction these portable sawing rigs made possible, as much as any other agency, the rapid construction progress attained. The portable sawing outfit, here illustrated, is the "Sultan" portable saw rig No. 3-B. In this unit a 7 h. p. "Sultan" engine furnishes ample power for the 14 to 16-in. saws and gives a diversified kind of work. Any skilled carpenter can operate this machine satisfactorily. It is claimed that the operating expense is very low. It will do the work of several men with hand saws. It is a combination machine, a combination of nine machines into one.

Builders soon learn to use the sliding cross-cut table and save 50 per cent. in time over the ordinary way of cross-

cutting, sliding the material through the saw rather than forcing the material into the saw. Perfect jointing is also possible and safely done on the jointer head, rabbeting, grooving is also accomplished on this machine without effort. Sanding, boring and ripping is also accomplished just as readily as cross-cutting and saving the time of five or six good men—a combined power driven nine-machines-in-one for the cost of a single outfit.



PORTABLE GASOLINE COMBINATION SAWING OUTFIT.

The "Sultan" saw rig is constructed of steel and iron, making it indestructible and long lived—a warping table top is unheard of on an iron table top. The frame is made of angles much stronger than wood and more serviceable, with large hot rivets, riveted under an air riveter and forced in a homogeneous mass of strong steel and iron.

Plant Units Used on Camp Green Cantonment Construction

A great variety of construction plant units was utilized on the construction of the cantonments for the National Army and National Guard. Here is a list of the units employed by the Consolidated Engineering Company, of Baltimore, in the construction of National Guard Camp Green, at Charlotte, N. C.: Two 2-bag Lakewood concrete mixers; 32 1½-ton motor trucks; 1 No. 60 Marion steam shovel; 3 10-ton road rollers; 350 dump wagons of all kinds; 2 derricks; 15 6-h.p. portable Oshkosh saws; 5 12-bbl. Frick Manufacturing Company sprinkling wagons; 2 trench pumps; 3 road machines, and 2 Vulcan plows.

New Type of Dump Car for Heavy Service

A new type of dump car, here illustrated, has been perfected by the Western Wheeled Scraper Company. This car is designated as the Western Automatic Compression Lock. The dumping and righting of the car is accomplished by the use of two short-stroke vertical cylinders placed on either side of the car, the piston rods of these cylinders engaging with the underside of the bed through a hinged connection, called the push rod extension. The same general design of hinges and door operating mechanism is retained, which has proven so successful in Western cars for the last twenty years.

The features which are individual to this car are the means of unlocking, locking and controlling the position of the bed without the use of side chains or any fixed connection between bed and underframe. Owing to the very severe service required of these cars it was considered advisable to support the bed of the car in such a manner as to transmit the strains, due to dropping the heavy dipper loads, directly to the truck springs. This has been accomplished by using a strut, or post, hinged at the bottom end to the body bolster, the upper end being so designed as to follow, in a guide attached to bed, the motion of the bed, thereby positively controlling the motion of the strut.

In order to lock the car in carrying position a brace has been pivoted at the upper end of the strut, the lower end engaging with a cam, fastened to a rock shaft, which in turn is

WESTERN AUTOMATIC 20-YD. DUMP CAR.

operated by the movement of the piston in the cylinder. It readily will be seen that by this method all members between the bed and underframe are in compression, and the shock from loading is carried directly through the truck springs to the roadbed.

A Stone Spreader and Distributor

The Burch stone spreader and distributor is a labor saver. It spreads stone on roadways and obviates a fruitful source of labor shortage. The picture shows how the machine unloads and distributes. The spreader is provided with chains to hook to a motor truck. A gate at the rear of the spreader

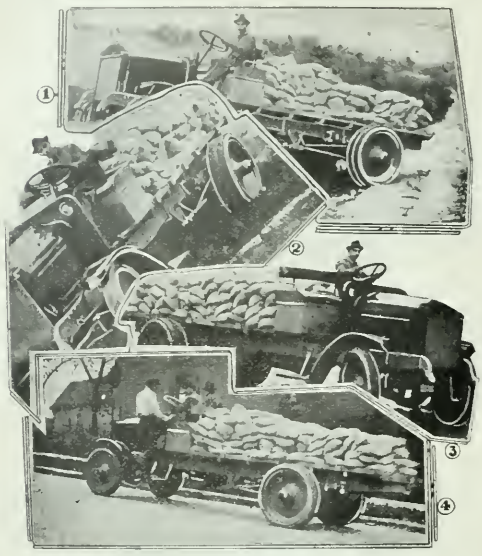
A NEW STONE SPREADER AND DISTRIBUTOR.

is adjustable to regulate the depth of stone. An even depth of stone distribution is secured. The machine is 7 ft. 4 in. long so it can be used in connection with any truck. Because of uniform spreading this machine saves material as well as labor. One contractor recently saved enough stone in two miles of road construction, it is claimed, to pay for his machine, while fully meeting the engineer's specifications.

A New Five-ton Motor Truck

A new 5-ton Titan motor truck, manufactured by the Titan Truck Company of Milwaukee, is built especially for contract trade. It is constructed throughout according to government specifications for large war trucks. It is said to be the first truck that ever made the Nineteenth street grade in Milwaukee under a capacity load. As a part of the test program the truck was loaded with five tons of concrete in bags. It climbed

the Nineteenth street hill, a 20 to 25 per cent. grade, 500 feet long, on first gear, with the governor holding the motor to a maximum of 1,000 r.p.m., without a falter. It is claimed that the Titan is the first American truck of the large internal

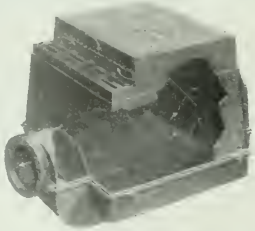


VIEWS OF THE TITAN TRUCK IN ACTION.

gear type to be fitted with radius rods. It has a road clearance of 16 in. under the solid rear axle. The transmission gears are shifted by dog clutches, making it impossible to strip or injure the gears. The chassis is built to carry more than its own weight, which tends toward economy in all directions. The views, herewith, show this new truck in action.

An Odorless Cast Iron Sanitary Catch Basin

The odorless, all cast iron, sanitary catch basin, here illustrated, is not an experiment. It has been on the market for the past five years, and within the last year it has been perfected in detail, and its sale is now being pushed. The odorless sewer basin costs somewhat more than brick or concrete basins, but it is claimed that this higher first cost is more than

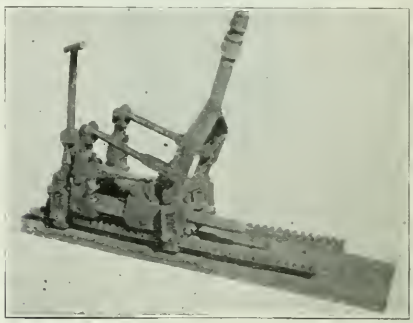


AN ODORLESS SEWER BASIN.

balanced by reduction of other costs. It is easily installed by any laborer, and is easily moved to meet grade or other changes. It is claimed that one man with a long-handled shovel can clean twice as many of these basins in a day as he cleaned of the old types of basins in ten days. The basin is constructed throughout of pure cast iron. The upper part, including street grating, is a separate casting, secured by lugs and bolts, so that any special design can be furnished to meet city requirements. This also allows the top to be turned so that the sewer connection can be run in any direction. It has a broad, flat bottom and is easily handled on rollers.

A Pipe Pusher That Saves Pavements

The Easy pipe pusher, here illustrated, puts pipe under ground with a minimum of digging and a minimum of damage to pavements. It is claimed that this device will put in from 30 to 150 ft. of pipe at any depth in an hour. It will push pipe under paving, floors, streams and other difficult places as



A DEVICE FOR PUSHING PIPE UNDER PAVING.

quickly and cheaply as in the open. The speed depends on the soil and the operator. The machine saves from 75 to 85 per cent. of the digging. In ordinary work it only requires a short ditch to set the machine to start. Where the pipe is to be pushed long distances, a small hole about 18x36 in. must be dug every 50 to 75 ft., to know the pipe was correctly aligned, and is going the exact direction desired. In working from a basement, 300 ft. of pipe could be put in by digging four or five holes a total distance of probably 12 ft. The distance between the holes depends upon the accuracy of the operator's eye. The pusher will work under pavement, walks, floors, streets or lawns. It will draw out old, damaged pipe, and replace with new; draw lead pipe and cable through under ground, or through conduit, after putting the conduit in. It will work any place digging can be done, and in some places where digging would be very difficult.

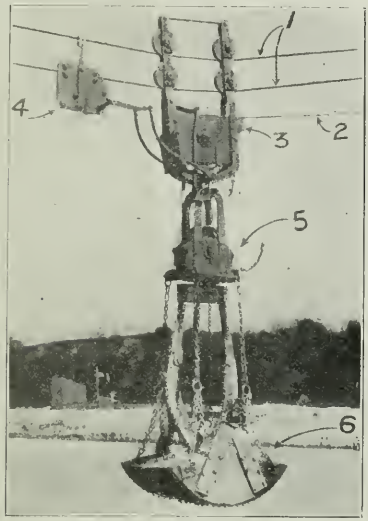
Clam Dredging Sand on Nebraska Rivers

Sand production by dredging on Nebraska rivers is carried on with drawline dredges and clam dredges. Clam dredgs are operated either by cranes or on double cables. About 20 dredges load sand in the state for eight months of the year. Most clam dredges operate along the lower Platte producing from the sandy alluvium where the stripping is thin and the water table is near the surface. They are located on railroad spurs which extend to accessible sand ground near the towns. The cost of a clam dredging plant, not including the railroad spur, is from $3,000 to $5,000. Rainy weather does not interfere very much with the operation of the plant.

The equipment of a dredge operating on a tram supported by towers is given by George E. Johnson, state engineer, as follows: Railroad spur, engine and engine house, towns and anchors for cables, double cable, carrier and block, clam dredge, draw line, scrapers, shovels, etc., for stripping and loading, and equipment for screening and grading.

Large towers are erected 200 ft. or more apart to hold the heavy cables upon which the dredge proper operates. The

tower at the dumping end of the cable is the higher. It is built of heavy timber. Strong cables connect from the upper ends of the towers with heavy anchors. These support the double cable or tram line. The clam dredge proper, here illustrated, weighs from 2,000 to 3,000 lbs. The numbered parts in the view are: 1, double cable; 2, draw line; 3, carrier; 4, trip block; 5, block head, and 6, clam shell. The clam dredge is built of heavy crucible steel. Its halves or clams are hinged



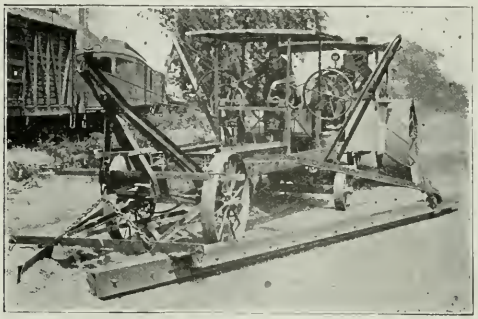
CLAM DREDGE USED ON NEBRASKA RIVERS.

to a steel bar about 3 inches in diameter and attached to a clam head by heavy chains and levers. The clam head, weighing about 500 lbs., contains strong pulleys through which passes a draw line cable about ¾ in. in diameter. A carrier, weight 1,000 to 1,500 lbs., runs on the double cable. The weight of the dredge, the block head, carrier and sand load is supported by the double cable.

When operating, the clam dredge, block head and carrier, run out on the double cable from the high tower to the trip block by gravity. Upon reaching the trip block the open clam and block head descend to and through the water to the sand. The block head lowers, strikes and catches the hinge bar and as the dredge starts to rise, the clam shells close in on the sand, scooping up a load weighing 2,000 to 3,000 lbs. or more. This load is carried upward to the carrier and trip, then to the high tower, where it is dumped into storage, into a washing and grading plant, or directly into a car. Working at the average rate, a dredge makes a trip in about 80 seconds, varying with the distance and depth of working. From 6 to 20 cars of 40 tons or more each are loaded at a plant in 8 to 10 hours.

A Self-Operating Road Leveler

The blades of the "Uncle Jim" self-operating road leveler are each 25 ft. long and 12 in. high and weigh 1,000 lbs. This Baker "Uncle Jim" road leveler grades any road up to 30 ft. in width in passing over it a single time. An ordinary 15 to 25 h. p. tractor developing the rated power on the draw-bar will handle this machine successfully on ordinary roads. One man easily operates the leveler. The blades can be worked independently. The blades can be drawn in for passing through narrow bridges. The machine can be easily turned around in its own length of 30 ft. The principal dimensions of the leveler are as follows: Length of main frame, 20 ft. 6 in.; distance between axles, 14 ft.; diameter of front wheels,

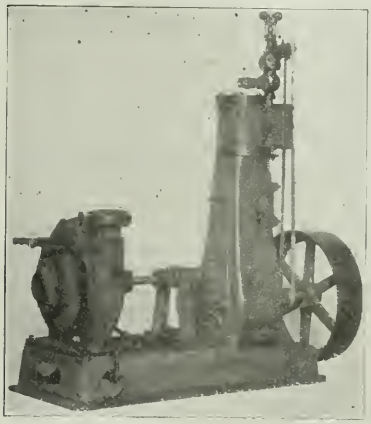


THE "UNCLE JIM" ROAD LEVELER.

24 in., and of rear wheels, 42 in.; width of tires, 6 in.; width center to center rear wheels, 4 ft. 8 in.; width center to center front wheels, 3 ft. 4 in.; weight of leveler about 6,300 lbs.

An Asphalt Pump for Paving Construction

A steam-jacketed, centrifugal asphalt pump for road builders is here illustrated. It is designed by Hetherinton & Berner to replace the air compressor and mechanical agitation in modern asphalt plants. The view shows one of these pumps direct-geared to a vertical automatic engine. The pump was especially designed for handling asphaltic cement and bitu-



A STEAM-JACKETED CENTRIFUGAL ASPHALT PUMP.

mens and oils of allied nature. It has removable heads on both sides. The pump may be assembled either right hand or left hand. It is easily applied to portable road asphalt plants, having any arrangement of kettles. Steam-jacketed asphalt pipe lines are obtainable for use with the pump.

Sewer and Conduit Rods

One of the conveniences of conduit and sewer operation which warrants frequent notice is that sold by Harold L. Bond Company, Boston, Mass., which has the Felton improved couplings. They do not separate under push or pull and the sections are short enough to handle easily in manholes.

DIGEST OF THE ESSENTIAL NEWS

Alabama Getting Ready for Federal Aid Road Construction

W. S. Keller, engineer of the Alabama State Highway Department, Montgomery, writes under date of October 13, as follows:

We have been busy during the current year preparing for Federal aid. By an act of the last legislature, approximately 3,000 miles of road, touching every county in the state, were declared state trunk roads. The same act made it illegal to use state funds on any other than a state trunk road unless all trunk roads in a county applying for aid were already constructed to the satisfaction of the State Highway Department. In case a county has its trunk roads all properly constructed, they may secure state aid for any other main traveled thoroughfare approved by the state engineer.

The government has made the same requirement as to the use of Federal aid. In order that every county in the state might have a fair chance to complete its trunk roads the State Highway Commission allotted Federal aid to an amount not to exceed $12,000 to each county. To date 25 projects have been submitted to the secretary of agriculture. Twelve have been approved, two disapproved and the remainder are being considered. By January 1 we expect to have actual construction work under way on at least 20 projects.

Labor is badly disorganized, but with the completion of work at the various army camps we hope for a betterment of conditions.

Governor Lowden (Illinois) Names Waterway Board

Governor Lowden of Illinois has given impetus to the deep waterway movement in Illinois by the creation of a board of water resource advisers. The personnel of the first board is a guaranty that the administration favors a seagoing channel. E. S. Conway of the Kimball Company, Joy Morton and John T. Pirie, the Chicago members, are all enthusiastic deep waterway promoters. George T. Page, a Peoria lawyer, and Charles B. Fox of East St. Louis, the downstate members, also are water route enthusiasts.

This new board, which will work under Leslie D. Puterbaugh, director of public works and buildings, and W. L. Sackett, superintendent of the division of waterways, will turn its attention first to obtaining a waterway connection between Joliet and the Illinois river at LaSalle. This is a step in the working out of the lakes-to-the-gulf waterway. Mr. Conway is a pioneer in the water route propaganda. It is Governor Lowden's desire to unite all interests in a common plan of waterway development and to this end he asks the cooperation of all civic bodies and citizens generally who have made a study of the subject.

The United States Liberty Motor Truck

The first Liberty motor truck, the product of the combined genius of 12 motor truck plants and 62 automobile parts factories, has been completed.

The standardized machine, of which 35,000 will be turned out the first half of 1918, represents the perfection of automobile development, the work of the greatest motor truck designers in the country.

The Gramm-Berstein Company of Lima, Ohio, was chosen to build the first model. Ralph Austin, engineer of the Gramm plant, is chairman of the standardized motor truck committee of the national defense committee, and had a leading part in designing the truck.

This standardized machine was built in the greatest secrecy to protect it from enemy eyes. A building without windows and lighted only by skylights housed the truck during the three weeks of its construction. The plant was closely guarded by armed men night and day.

Similar precautions surrounded parts manufactured in the sixty-odd factories which contributed to the machine. As each part was completed it was dispatched to Lima in charge of an army representative, who kept factory officials informed of his progress by telegraph. No one company knows the complete design or what other companies made other parts.

The new truck carries more than 1,000 pounds of dead weight more than commercial trucks of corresponding capacity.

A Unique Engineering Agency Created by United States Department of Labor

In normal times when an employer is in need of help he has only to post a notice in front of his establishment to secure the necessary help. At times, however, he requires men of special qualifications who are not only skilled mechanically but who also know the underlying principles of their occupation; that is, engineers (mechanical, electrical, civil, etc.). Suitable help of this character is not abundant, and is frequently quite scattered, hence much valuable time is lost to the employer and the available engineer in finding each other. A great need is some central office where available engineers could register, and where complete and up-to-date information concerning their qualifications could be kept on file. Employers, when in need of such help, could then report their needs to this central office with the assurance that that office was fully informed as to where suitable help could be secured.

Bringing Engineers and Employers Together

With this in mind the United States Department of Labor recently created, as a part of its employment service, a division whose function it is to aid the employer in obtaining suitable help and professional persons in securing suitable employment. This is known as the Teachers' and Professional Service Division. While intended to embrace all professions, attention has thus far been confined to the teaching and engineering professions. The services of the division are absolutely free to both employer and employe, all expenses being borne by the United States government. Its methods are quite thorough, and no service is rendered the applicant until the division has learned, from persons familiar with the applicant, that he is qualified as to training, experience and personal qualities for the position he seeks. When an applicant is recommended for a reported vacancy, the employer is given an opportunity to examine the data gathered in the course of this investigation, thus effectually preparing for the final and most important step, the personal interview, and for this ample facilities are provided in the offices of the division, where employers may meet with prospects on appointment.

The Service Is Free

Employers and professional engineers everywhere are invited to avail themselves of the services of this division, which,

as stated above, are entirely free. Employers in reporting positions are asked to state the nature of the position, its duties, requirements, etc., the probable salary and the probable duration of employment. Applicants for registration should indicate in the first letter the nature of the position desired so that the proper blank may be furnished. All communications should be addressed: Teachers and Professional Service Division, United States Employment Service, 845 South Wabash Avenue, Chicago, Ill.

Paving Brick Industry to Hold Conference in Cleveland

Out of war conditions—the breakdown of railroad and express companies to move crops and supplies and the extraordinary demand for better roads—the paving brick industry has been confronted with problems whose solution lies in study and conference on the part of all manufacturers. The annual meeting of the National Paving Brick Manufacturers' Association, to be held in Cleveland on November 19 and 20, will be the occasion of such a conference, to which are invited all manufacturers of paving brick.

The office board of the National Paving Brick Manufacturers' Association is convinced that more good to the country and to the industry can be effected by a conference in which the entire industry is represented by its active executive officials than by any other undertaking.

Experienced Highway Construction Men Wanted for Service in France

Men who have had experience in any branch of road construction are offered an opportunity to see early service in France in special road-building battalions of the United States army by recruiting plans here announced. These battalions will be required to repair and maintain the highways near the fighting front, over which tremendous traffic is operated continuously. They will also build new strategic highways in the war zone. Consequently, these troops, all volunteers, will be in the thick of the greatest activities.

The new battalions are constituted as regular military units and as a part of the regular army organization. They are fully armed and will be required in emergencies to fight along with the other troops. Generally, however, they will be occupied with road work.

The battalions will form a part of the 23rd Regiment of Engineers of the new national army. This regiment will eventually have a strength of about 10,500 men—more than an ordinary brigade—and will, so far as is at present known, be the largest in the army. It will be commanded by Col. E. N. Johnston of the Corps of Engineers, U. S. A.

Those interested should address: Commanding Officer, 23rd Engineers, National Army, 1419 F Street, Washington, D. C.

U. S. Chamber of Commerce for Military Roads

The following resolutions were adopted by acclamation at the recent War Convention of the Chamber of Commerce of the United States:

Whereas, it is essential that all transportation facilities of the nation should be brought to the highest state of efficiency in order that foodstuffs may be moved most economically from the farm to the market, that manufactured products be moved at the lowest cost from the factory to the consumer; and,

Whereas, the public highways offer a good, prompt and economical means to supplement transportation by rail and water; therefore, be it

Resolved, that the prompt improvement of our public highways is important and should be forwarded in every proper way.

ADVANCE INFORMATION ON BIG JOBS

The $25,000,000 Flood Prevention Project at Dayton, Ohio

Contracts for $10,000,000 worth of work on the $25,000,000 flood prevention project at Dayton, Ohio, will be let on November 15, 1917. This is the largest project of the kind ever undertaken.

Contracts 1 to 5 Inclusive—Dams and Appurtenances

Until 2 p. m., November 15, 1917, bids will be received for the construction of dams and appurtenances, as follows, at the office of the Secretary, Board of Directors, The Miami Conservancy District, Dayton, O.:

Contract No. 1—Germantown Dam and appurtenances, including Road No. 1, involving approximately the following principal quantities: Excavation, 200,000 cu. yds.; embankment, 850,000 cu. yds.; concrete, 20,000 cu. yds.; paving and riprap, 1,000 cu. yds.; iron and steel, 120 tons.

Contract No. 2—Englewood Dam and appurtenances, including Road No. 3, Road No. 4 and Road No. 5, involving approximately the following principal quantities: Excavation, 375,000 cu. yds.; embankment, 3,500,000 cu. yds.; concrete, 38,000 cu. yds.; paving and riprap, 2,000 cu. yds.; iron and steel, 180 tons.

Contract No. 3—Lockington Dam and appurtenances, including Road No. 8 and Road No. 9, involving approximately the following principal quantities: Excavation, 200,000 cu. yds.; embankment, 1,000,000 cu. yds.; concrete, 37,000 cu. yds.; paving and riprap, 1,000 cu. yds.; iron and steel, 50 tons.

Contract No. 4—Taylorsville Dam and appurtenances, including Road No. 12 and Road No. 13, involving approximately the following principal quantities: Excavation, 750,000 cu. yds.; embankment, 1,100,000 cu. yds.; concrete, 57,000 cu. yds.; paving and riprap, 5,000 cu. yds.; iron and steel, 400 tons.

Contract No. 5—Huffman Dam and appurtenances, including Road No. 16 to Station 60+50, and Road No. 17, involving approximately the following principal quantities: Excavation, 300,000 cu. yds.; embankment, 1,400,000 cu. yds.; concrete, 45,000 cu. yds.; paving and riprap, 1,500 cu. yds.; iron and steel, 400 tons.

Flood Control Works at Dayton and Hamilton

At the same time and place bids will be received on the following contracts:

Contract No. 41—Improvement of Miami River at Dayton, above Island Park, involving approximately the following principal quantities: Levee embankment, 65,000 cu. yds.

Contract No. 42—Improvement of Miami River at Dayton, Island Park to Washington street, involving approximately the following principal quantities: Channel excavation, 850,000 cu. yds.; concrete in retaining walls and revetment, 25,000 cu. yds.; levee embankment, 80,000 cu. yds.

Contract No. 43—Improvement of Miami River at Dayton,

Washington street to Stewart street, involving approximately the following principal quantities: Channel excavation, 465,000 cu. yds.; levee embankment, 205,000 cu. yds; concrete in retaining walls and revetment, 3,500 cu. yds.

Contract No. 44—Improvement of Miami River at Dayton, Stewart street to Broadway, involving approximately the following principal quantities: Channel excavation, 1,000,000 cu. yds.; levee embankment, 655,000 cu. yds.; concrete in revetment, 2,000 cu. yds.

Contract No. 45—Improvement of Mad River at Dayton, involving approximately the following principal quantities: Channel excavation, 20,000 cu. yds.; levee embankment, 35,000 cu. yds.; concrete in retaining walls and revetment, 1,500 cu. yds.

Contract No. 46—Improvement of Wolf Creek at Dayton, involving approximately 80,000 cu. yds.; levee embankment, 25,000 cu. yds.; concrete in revetment, 1,400 cu. yds.

Contract No. 58—Improvement of Miami River at Hamilton, involving approximately the following principal quantities: Channel excavation, 1,900,000 cu. yds.; concrete in retaining walls and revetment, 27,000 cu. yds.; reinforcing steel, 550,000 lbs.

Many Sub-contracts

The larger contracts to be let contain numerous smaller pieces of work for which the main contractor may not be equipped, and which he may desire to sublet. The chief engineer of the Conservancy District, Arthur E. Morgan, would be pleased to hear from any persons or firms who would be in position to take any of these subcontracts, and will put them in touch with those who will bid on the larger contracts as a whole. Some of the kinds of work which may be included in these subcontracts are:

Clearing and grubbing trees from base of dam. Soil stripping from base of dams, levees and borrow pits. Surface dressing and grassing of dams. Seeding or sodding of levees. Trimming slopes of river channels. Removal of buildings. Excavation for minor drainage systems. Construction of levees. Excavation and fills for highway construction. Rolled gravel paving for highways. Water bound macadam paving for highways. Street paving; bituminous macadam, brick, concrete, etc. Guard rails for highways. Construction of wire fences. Laying vitrified pipe. Gutter paving. Stone masonry. Stone paving. Riprap. Small concrete structures. Road culverts. Concrete slope revetment for river banks. Concrete blocks for slope protection. Setting flood gates in canals and sewers.

Information for Bidders.

The District has published a 50-page pamphlet, giving information for bidders, containing a list of the contracts, information for bidders, list of contract items and estimates of quantities. The information for bidders covers such matter as natural gas, coal, electric power, telephone service, freight service, sources of supply of sand and gravel for concrete, stone for stone masonry, rubble paving and riprap and flood warnings.

The Columbus Channel Improvement Job Involves Much Earth-Moving and Concreting

The Columbus (Ohio) flood protection work involves channel improvements which entail large earth moving and concreting operations. The earth excavation and fill amount to about 2,000,000 cu. yds. There is also a concrete overflow dam 20 ft. high and about 600 ft. long, a reinforced concrete levee wall 24 ft. high and 1,200 ft. long to serve as an emergency spillway, and a considerable quantity of reinforced concrete revetment paving. The entire job will be handled in one contract. The cost-plus method of awarding the contract may be used.

The channel widening extends over a distance of about two miles and represents a depth of cut averaging 20 ft. and is several hundred feet wide. There is no rock in the channel. The slopes of the new channel will be trimmed and seeded in grass. The material excavated will be used in building levee embankments along both sides of the channel. About half the excavation spoil will be moved downstream to form levees along a two-mile stretch below the section widened. The levees will be 80 ft. wide on top, at least. The one bridge included in the contract has seven arch spans, ranging from 78 to 105 ft., with deck width of 60 ft.

The work will all be done in the Scioto river, between the mouth of the Olentangy river and the Columbus sewage pumping station, a total distance of about four miles.

George A. Borden is director of public service and Henry Maetzel is city engineer. The estimated cost (made a year ago) is $1,750,000, but about $2,000,000 is available for the work, including the purchase of some real estate.

How the Contractors are Bidding

Bids on Sewer Construction at Menomonie, Wis.

Table I herewith gives the estimate of cost of sanitary sewer work in Menomonie, Wis., and the bids received on this work. We are indebted to C. E. Huntington, city engineer, for the bids and descriptive information given.

The average cut on the 18-in. vitrified sewer was 12 ft. and 8 ft. on the 15-in. and 8-in. sewers scheduled in Table I.

All excavation in second district was sand and gravel, making tight sheeting necessary. The sheeting was driven by hand and pulled by stone mason's derrick, operated by two men; all hand excavation.

First district was sand and gravel for 2,400 ft., with tight sheeting used under same conditions as given. Balance of 18-in. pipe and all 15-in. and 8-in. was laid in open ditch through

TABLE I—ENGINEER'S ESTIMATE AND BIDS ON SEWER JOB AT MENOMONIE, WIS.

Quantities	City Engineer's Estimate		R. R. Hunt Menomonie, Wis.		Cast Stone Constr. Co. Eau Claire, Wis.		Wm. C. Fraser St. Paul, Minn.	
First Sewer District—								
2,610 feet 18-inch Vitrified Pipe	$ 1.65	$4,306.50	$ 1.57	$4,097.70	$ 2.20	$5,742.00	$ 2.10	$5,481.00
730 feet 15-inch Vitrified Pipe	1.25	912.50	1.23	897.90	1.20	876.00	1.20	876.00
1,020 feet 8-inch Vitrified Pipe	.90	918.00	.94	958.80	.60	612.00	.70	714.00
8 Manholes	48.00	384.00	55.00	440.00	50.00	400.00	50.00	400.00
10 Catch Basins	48.00	480.00	55.00	550.00	35.00	350.00	50.00	500.00
Second Sewer District—								
661 feet 15-inch Vitrified Pipe	$ 1.25	$ 826.25	$ 1.18	$ 779.98	$ 1.35	$ 892.35	$ 1.35	$ 892.35
75 feet 8-inch Vitrified Pipe	.90	67.50	.94	70.50	.60	45.00	.75	56.25
2 Manholes	48.00	96.00	55.00	110.00	50.00	100.00	55.00	110.00
4 Catch Basins	48.00	192.00	55.00	220.00	35.00	140.00	50.00	200.00
		$8,182.75		$8,124.88		$9,157.35		$9,229.60

TABLE II—BIDS RECEIVED ON SEWAGE DISPOSAL PLANT AT STAMFORD, CONN., SEPT. 22, 1917.

Description	Quantity	Engineer's Estimate Unit	Engineer's Estimate Item Total	Frank Palmer Unit	Frank Palmer Item Total	Eaton, Brown & Simpson, Inc. Unit	Eaton, Brown & Simpson, Inc. Item Total
Protective Work and Royalties	Lump sum	.....	$ 5,500.00	.....	$ 26,500.00	.....	$ 31,268.00
Excavation	17,000 cu. yds.	$ 1.50	25,500.00	$ 1.25	21,250.00	$ 1.32	22,440.00
Rolling Enbankment	11,000 cu. yds.	0.20	2,200.00	0.65	7,150.00	0.29	3,190.00
Concrete	3,500 cu. yds.	16.00	56,000.00	21.25	74,375.00	17.25	60,375.00
Reinforcing Steel	200,000 lbs.	0.06	12,000.00	0.06	12,000.00	0.069	13,800.00
Cast Iron B. & S. Pipe	43.5 tons	75.00	3,262.50	75.00	3,262.50	103.60	4,506.60
Cast Iron B. & S. Specials	15.5 tons	115.00	1,782.50	80.00	1,240.00	189.00	2,929.50
Cast Iron Flanged Pipe and Specials	5.0 tons	150.00	750.00	90.00	450.00	262.00	1,310.00
Gate Valves	Lump sum	.....	600.00	.....	712.00	.....	791.00
Sluice Gates	Lump sum	.....	3,000.00	.....	2,327.00	.....	4,179.00
Check Valves	Lump sum	.....	225.00	.....	223.00	.....	350.00
6-in. Flap Valves	8 each	15.00	120.00	17.00	136.00	17.875	143.00
8-in. Flap Valves	2 each	25.00	50.00	20.00	40.00	40.00	80.00
4-in. Vit. Pipe	1,200 lin. ft.	0.15	180.00	0.25	300.00	0.20	240.00
6-in. Vit. Pipe	20 lin. ft.	0.20	4.00	0.35	7.00	0.41	8.20
8-in. Vit. Pipe	450 lin. ft.	0.35	157.50	0.75	337.50	0.50	225.00
10-in. Vit. Pipe	700 lin. ft.	0.45	315.00	1.25	875.00	0.66	462.00
Structural Steel	65,000 lbs.	0.09	5,850.00	0.07	4,550.00	0.109	7,085.00
Misc. Cast Iron, Wrought Iron & Steel	20,000 lbs.	0.15	3,000.00	0.06	1,200.00	0.185	3,700.00
Railings	480 lin. ft.	2.00	960.00	1.25	600.00	1.84	883.20
Screen Chamber Superstructure	Lump sum	.....	900.00	.....	5,700.00	.....	1,322.00
Laboratory Bldg. Superstructure	Lump sum	.....	7,500.00	.....	7,325.00	.....	9,883.00
Lumber	13 M. ft. B. M.	85.00	1,105.00	50.00	650.00	149.60	1,943.50
Baffles, including reinforcement	2,560 sq. yds.	2.75	7,040.00	1.00	2,560.00	3.51	8,985.60
Venturi Meter	Lump sum	.....	1,500.00	.....	1,650.00	.....	2,235.00
Chlorinating Apparatus	Lump sum	.....	1,400.00	.....	2,175.00	.....	1,557.00
Automatic Tide Gate	Lump sum	.....	500.00	.....	300.00	.....	575.00
Chemical Equipment & Piping	Lump sum	.....	2,500.00	.....	2,900.00	.....	3,644.00
2-in. Water Line	500 lin. ft.	0.70	350.00	1.00	500.00	0.675	287.50
Electric Hoists	2 each	350.00	700.00	532.00	1,064.00	583.00	1,166.00
Railways, steel ties, straight track	860 lin. ft.	1.25	700.00	1.46	817.60	1.46	817.60
Railways, wooden ties, straight track	600 lin. ft.	1.60	960.00	1.90	1,140.00	1.22	732.00
Railway, wooden ties, curved track	100 lin. ft.	2.25	225.00	2.00	200.00	1.725	172.50
Switches	9 each	60.00	540.00	70.00	630.00	75.00	675.00
Tip Cars	2 each	140.00	280.00	195.00	390.00	204.00	408.00
2-in. Water Line in Settling Tanks	Lump sum	.....	850.00	1.00	1,366.00	.....	1,119.00
Crushed Stone, Sludge Beds	770 cu. yds.	2.00	1,540.00	2.75	2,117.50	2.59	1,994.30
Macadam	1,600 sq. yds.	1.25	2,000.00	1.00	1,600.00	1.78	2,848.00
Pressure Water Pump & Motor	Lump sum	.....	500.00	.....	650.00	.....	632.00
Connecting Existing Pumps	Lump sum	.....	300.00	.....	500.00	.....	287.00
Fence	865 lin. ft	0.50	432.50	1.25	1,081.25	0.62	449.80
Total			$153,279.00		$192,857.35		$199,699.30

clay-gravel material and no sheeting necessary. The original estimate and all contractors figured on hand digging.

Manholes and catch basin of brick with 6-in. concrete floor and cast iron covers of city engineer's own design, made in local foundry.

Bids Received on Stamford, Conn., Sewage Disposal Works

Table II herewith gives a schedule of the bids received on the sewage disposal plant contract at Stamford, Conn., on September 22, 1917.

In addition to the bids scheduled the Suburban Engineering Company proposed to do the work at cost plus $12,500. The engineer's estimate was made in May, 1917, using the prices in force at that time.

Fuller & McClintock, 170 Broadway, New York city, were the consulting engineers on this job, and we are indebted to them for the information here given. Paul Nash is city engineer of Stamford.

Bids on Deep Well and Pump at Cuba City, Wis.

Bids were received on a deep well and a deep well pump at Cuba City, Wis., on July 12, 1917. The information here given was submitted by J. G. Thorne, civil engineer, Clinton, Iowa, who was consulting engineer on the job.

Specifications and Bids on Well

The specified sizes and depths of the well were as follows:

The bore shall be 12 in. for 250 ft. and 10 in. for 500 ft. The 250 ft. of 12 in. shall be cased with standard wrought iron pipe; the pipe shall have an actual inside diameter of 12 in. and outside diameter of 12¾ in. and shall weigh 49 lbs. per lineal foot. The pipe shall be lap-welded and provided with a forged steel shoe and a proper head for driving. The intention is to case the new well below the bottom of the present well and prevent the present supply from flowing into the new well. The balance of the well shall be a 10-in. hole, through the solid rock, approximately 500 ft.

Two bids, each at $10 per foot, were received for the 250 ft. of 12 in. cased well. These bids were submitted by W. L. Thorne & Co. of Plattville, Wis., and M. T. Peterson of Madison, Wis. The first named contractor bid $4.50 per foot for the 10-in. well hole and the second bid $5.50 per foot.

Specifications and Bids on Pump and Motor

The deep well pump shall have a standard brass-lined working valve, double acting, with removable plunger with brass or bronze ball valves, 24-in. stroke and fitted for insertion into a 12-in. standard wrought iron well casing. The capacity of the pump shall be not less than 294 gal. per minute and shall operate at a piston speed of 100 ft. per minute. The pump cylinder will be approximately 200 ft. below the surface and shall pump against a head of 150 ft. above the curb.

The pump head shall be of a heavy type, adjusted for a stroke of 24-in. and shall be so arranged that it can be easily shifted to one side in case it becomes necessary to draw the pump rods.

The contract for the deep well pump and pump head shall include all necessary fittings to the well casing, check valves, gate valves, pressure gage, air chamber, sucker rods, drop pipe, belt, tight and loose pulleys and foundation bolts, and any and all accessories and fittings which may be necessary to complete the pumping unit within the station with the exception of the motor and wiring.

The motor shall be slip-ring, 30 H. P., 850 r.p.m., 3 phase, 60 cycle, 8 pole, 220 volts and one of the following makes: General Electric, Westinghouse, Wagner or Century.

W. L. Thorne & Co. of Plattville, Wis., bid $4,240 for the deep well pump and pump head in place, and $765 for the motor in place. They bid on a Downie pump and a 35 H. P. General Electric motor. Their bid for pump and motor was $5,005. They were awarded the entire contract at $9,755.

Other total bids received for pump and motor were: $5,286 by M. T. Peterson of Madison, Wis., for a Downie pump and $6,223 for an American pump; $5,170 by John W. Hildred & Co. of St. Paul for a Downie pump and 35 H. P. General Electric motor, and $5,130 by the Western Pump and Machinery Co., St. Paul, for Hannegan pump and 35 H. P. G. E. motor.

Lights and Shades

Confusing the Public

Engineers are constantly complaining that they are not properly understood and appreciated by the public, and at the same time they write stuff like this: "Engineering is a mode of thinking. Any man who considers all his problems without prejudice, who clearly discerns the facts from the opinions—the essentials from the non-essentials—and who searches continually for new truths and better methods, who is not controlled by superstition or precedent, who analyzes constructively or constructs analytically, is an engineer. His field work may be medicine, law, architecture, agriculture, mining, merchandising, machine design or chemical research." Is it any wonder the confused citizen plays safe and thinks of the original engineer as the man who ran the donkey engine in Noah's ark?

Kindred Spirits

A contractor who believed himself to be the sole survivor of a shipwreck upon an island inhabited by cannibals, hid for three days in terror of his life. Driven out by hunger, he discovered a thin wisp of smoke rising from a clump of bushes inland, and crawled carefully to study the type of savages about it. Just as he reached the clump, he heard a voice say: "Why in hell did you play that card?" He dropped on his knees, and, devoutly raising his hands, cried:

"Thank God, they are Christians!"

Old Stuff

Vitruvius, who was an architect and engineer in the time of Julius Caesar, wrote as follows regarding the qualifications of an engineer:

"An engineer should be ingenious and apt in the acquisition of knowledge; he should be a good writer, a skillful draftsman, versed in geometry and optics, expert in figures, acquainted with history, informed in the principles of natural and moral philosophy, somewhat of a musician, not ignorant of the sciences, both of law and physics, nor of the motions, laws and relations to each other of the heavenly bodies.

"Moral philosophy will teach the engineer to be above meanness in his dealings and to avoid arrogance. It will make him just, compliant, and faithful to his employer, and, what is of the highest importance, it will prevent avarice gaining ascendency over him, for he should not be occupied with thought of filling his coffers, nor a desire of grasping everything in the shape of gain, but by gravity of his manners and a good character should be careful to preserve his dignity."

You will now stand corrected.

The Dramatic Bricklayer

Otis Skinner, the actor man, tells a story in support of the theory that the poetic spirit is sometimes contagious. A Shakespearean company was rehearsing for an open-air production of "As You Like It" near Boston, and the garden wherein they were to play was overlooked by a rising brick edifice. As the players recited their lines, the workmen continued to lay their bricks. One afternoon, during a silent pause in the rehearsal, the players were startled to hear a voice from the building exclaim with the utmost gravity: "I prithee, malapert, pass me yon brick."

The Busy Wop

An Italian, having applied for citizenship, was being examined in the naturalization court.

"Who is the President of the United States?"

"Mr. Wils'."

"Who is the Vice President?"

"Mr. Marsh'."

"If the President should die, who then would be President?"

"Mr. Marsh'."

"Could you be President?"

"No."

"Why?"

"Mister, you 'scuse, please. I vera busy worka da mine."

The Engineer's Favorite

Six engineers have told us this one, so it must be good. The division engineer sent the rodman, with level and rod, to catch the 8:05 a. m. train out to that day's work. The engineer followed closely and met the breathless rodman rushing back to the office. "Good God," said the rodman, "we forgot the plumb-bob!"

A Natural Scientist

An engineer, visiting his boyhood home, met the father of his colored schoolmate. The father, in reply to an inquiry concerning his son, said: "Why, that boy has turned out something wonderful. He is a great natural scientist. Yes, sir, a great natural scientist. Oh, he just picked it up. It seemed to come natural to him. Why, that boy has painted signs on every road leading into this town!" The engineer later saw the signs and agreed that the colored man had just "picked up" the art of sign painting.

Remember Ben Gunn?

Do you remember Ben Gunn, one of Stevenson's pirates, who was scandalized at the recollection of and who traced his downfall to "playing chuckoluck on the blessed gravestones?" Ben's descendants have gone him at least one better. It is reported that tombstones are not infrequently employed in different parts of England for paving purposes. Some four or five years ago the inhabitants of Belvoir bitterly protested against the use of such material in the construction of a road leading to the parish church, despite the assurances of the local authorities that with the liberal supply of old and broken gravestones at their disposal, the plan had been adopted with a view to saving the taxpayers quite a sum.

Telephones Unknown in Rural Ireland

Patrick, lately over, was working in the yards of a railroad. One day he happened to be in the yard office when the force was out. The telephone rang for some time, before Pat came to the conclusion that it ought to be answered. He approached the instrument cautiously, and slowly put the transmitter to his mouth, as he had seen the "boss" often do.

"Hillo, there," he called.

"Hello," answered some one at the other end, "is this eight-six-ought-four-eight?"

"Aw, g'wan; phat d'ye think Oi am, a box car?" replied Pat.

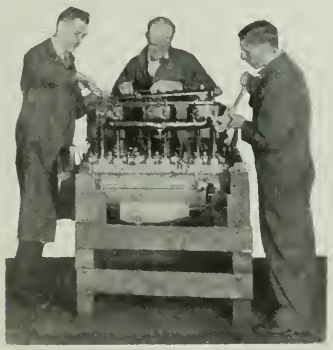
Sales Engineering

How the Pierce-Arrow Motor Car Co. Trains Automobile Salesmen

By Harold H. Hodge, Manager of the School for Salesmen of the Pierce-Arrow Motor Car Company.

The Pierce-Arrow sales school is proving to be of great importance in the development of the Pierce-Arrow selling organization. There are few men in the industry today who appreciate the system the company employs in training men to sell pleasure cars and trucks. It may be said that the company now endeavors to use the same care in training its selling force that it uses in the manufacture of its products.

If the selection of perfect material with which to build trucks and automobiles is of prime importance in the manufac-



STUDENTS DIS-ASSEMBLING MOTOR IN PIERCE-ARROW SALES SCHOOL.

turing end of the business, the selection of perfect material from which to build salesmen is certainly of no less importance in the commercial end. It is the first aim of the Pierce-Arrow Motor Car Company to select men of the caliber, experience and qualifications which promise success for themselves as well as for those of our agents who may wish to employ them on the completion of their course of training.

How the School Is Organized

The school is designed to give prospective salesmen instruction in four requisites deemed fundamental:

First, a thorough understanding of the Pierce-Arrow tradition and policy and an absorption of the Pierce-Arrow spirit which creates the enthusiasm and confidence without which a salesman cannot succeed. Second, mechanical knowledge. Third, transportation problems. Fourth, sales knowledge, methods and arguments.

Pierce-Arrow Spirit

We believe every Pierce-Arrow salesman who has an understanding of the policy and traditions of this institution and our methods of business will have an enthusiasm and loyalty for the organization which will be reflected in his work.

With this in mind, the school is given the history of the institution, quantities of its literature, past as well as present, and talks pertaining to policy by executives.

Occasional talks not directly related to selling problems are given when it is believed they serve to convince the salesman of our steadfast adherence to our ideals and traditions. This is all on the assumption that a salesman cannot sell until he himself is sold.

Sales students are also taught where, how and in what respect the factory is prepared to lend a hand to our agents and their salesmen in convincing prospects—the use, for instance, of photographs, statistics, special data, etc.

Mechanical Training

A large, well lighted room called the sales school mechanical department is devoted to truck and pleasure car components, such as motors, transmissions, frames, rear axles, steering columns, etc., each on its own bench. In another equally large room, known as the students' lecture room, instructions are given on lines similar to those of a college course.

Virtually every production, service, factory and selling official with the Pierce-Arrow organization is included in the schedule of lectures.

Each week's schedule contains its quota of mechanical work, mechanical lectures, trips through the factory and quizzes. The various automobile units mentioned above are turned over to groups of two or three students for disassembling under instruction. This takes about one week for each unit. The function of the parts are thoroughly explained. The various methods employed by other manufacturers are discussed, materials, clearances, etc., are noted and the various selling arguments of the particular units are dwelt upon. Each group then reassembles its unit and proceeds to the next, thus progressing through each unit until the final assembling of the chassis. The students are required to do all the work themselves according to a prearranged system.

In connection with this mechanical education trips are made through various departments of the factory. Students are, for example, shown how Pierce-Arrow wheels are built, how the aluminum bodies are constructed, etc. These trips cover a dozen or more departments.

An important feature of the mechanical education is the series of lectures given by the Pierce-Arrow engineers and the heads of the various factory departments.

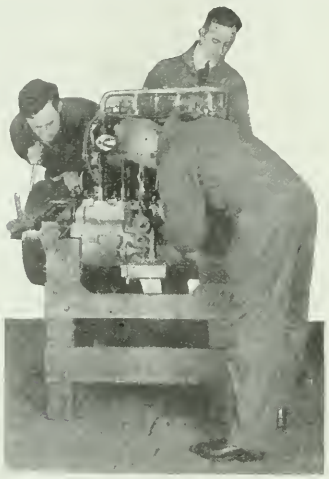
The mechanical part of the lecture course covers such subjects as the following: Differentials, wheels, ignition, magnetoes, leather and upholstery, pleasure car rear axles, truck rear axles, pleasure car engines, truck engines, truck engine materials, pleasure car engine materials, power equipment as applied to our trucks, five-ton truck, two-ton truck, pleasure car front axles, truck front axles, the steering column; how our experimental department protects the customer against mistakes in construction; electrical equipment for trucks, electrical equipment for pleasure cars, six, eight and twelve-cylinder engines, standard truck bodies.

These are but a few of the technical subjects upon which engineers and experts speak. A fair knowledge of competitive mechanical features is not overlooked, and their respective merits and deficiencies are explained.

Transportation Problems

A real truck salesman realizes that he is not selling a truck, but transportation. As a piece of machinery the Pierce-Arrow truck is high priced; as a method of transportation it is extremely low in cost. At first this sounds like "begging the question" of price; but it is only as a student acquires a knowledge of transportation problems that he can realize that (with its small depreciation, its great dependability and free-

dom from repairs and because of its long life) the Pierce-Arrow motor truck as an investment covering a number of years is very economical. These are points of value in proportion as they are made specific. Salesmen are taught, for example, if they are selling a coal dealer, these points and others should be made to fit precisely with the prospect's coal business. With this idea in mind the student is taught the transportation end of the coal business. This is accomplished in part in the classroom, but it is chiefly acquired by the student himself who is permitted a week's investigation of the transportation end of the coal business of one of the many owners of Pierce-Arrow truck fleets. During this week he rides on Pierce trucks, notes loading and unloading time, number of trips, running speeds, loading methods, number of stops, accounting methods, traffic conditions, etc. The result of this intimate knowledge of coal transportation problems thus acquired shows up in his efforts at selling coal dealers. He talks to his



ASSEMBLING 2-TON TRUCK MOTOR; AT LEFT, TIMING ENGINE; AT RIGHT, FITTING WATER PUMP; IN FRONT, MOUNTING CARBURETOR.

prospect from the latter's viewpoint. He sells a transportation method (which is what his customer wants) while his competitor very probably is trying to sell a truck (which is an expensive piece of complicated machinery which the prospect does not want to buy, but which is incidental to getting his transportation problem correctly solved). This study of transportation problems applies not only to the coal trade, but to various other lines of industry as well, such, for instance, as sand and gravel, brewing, contracting, general haulage, etc. Unfortunately no one salesman can afford the time for the study of the transportation problems of all lines of industry, but a representative number is given each man depending upon the nature of the field in which he is ultimately to work.

Sales Methods, Arguments, etc.

Before the inauguration of this sales school arguments used in selling Pierce-Arrow pleasure cars and trucks were as varied as the personalities of the salesmen. Each man's arguments and methods were based upon his individual experiences. Between two men of equal ability there existed wide differences of method.

An accumulation of information as to how the most successful salesmen accomplished their results is benefiting all other salesmen of the organization. A knowledge of the strongest arguments and the best methods are now being accumulated and dispersed through the sales school, which has become a clearing house for this material. This has proven of value not only to students but also to all those experienced and successful salesmen of all Pierce-Arrow agents who are alive to the opportunities it affords. Selling arguments on every feature of our trucks and pleasure cars are given to the sales students. Each is required to present his arguments in his own way. No sales argument is required to be rendered verbatim, as each student is encouraged to develop his own individuality.

Students are required to speak on their feet before others. "Speaking on your feet" is simple compared to "thinking on your feet." To develop this latter extemporaneous subjects are thrust upon the students who are also subjected to objections and contradictions. Mock sales are conducted, students taking turns as prospects and salesmen.

Mental initiative is encouraged in the students by requiring them to think out methods of their own and prepare sales arguments for themselves.

The lecture course of the sales end of the training is of the greatest value. This will be appreciated by a reference to the following partial list of subjects: Pierce-Arrow quality, general factory policy, mixing and business success, selling Pierce-Arrow motor cars, truck talking points, cumulative effect of intelligent methods, salesmanship from the buyer's point of view, truck salesmanship as a profession, transportation costs as selling arguments, some successful methods of selling, salesmen from the agent's point of view, modern automobile salesmanship, closing the sale, barriers to the sale and how to conquer them, getting prospects, price arguments, cost and depreciation, talking points for the pleasure car, high lights on truck selling, Pierce-Arrow service, selling fleets, inferences drawn from our sales distribution chart, the use of personal letters.

This series of lectures is augmented by talks by successful salesmen, many of whom talk informally to the class on their methods. A very complete course of lectures is also given comparing Pierce-Arrow with other makes—one talk upon each of the other types of truck or pleasure car.

How Students Are Enrolled

Prospective students are required to fill out a formal "application blank" in which is detailed confidential information. An interview is then arranged and the applicant, if accepted, is enrolled for membership in the next succeeding class. Students are paid during their course of training.

Unusual opportunities are afforded to men of the right caliber, ability, education and experience, especially at this time, when agents are losing so many good men because of the army draft.

Salesmen You Ought to Know

"Sales engineering," says Arthur W. Greetham, Manager of Excavator Sales for the Pawling & Harnischfeger Company, of Milwaukee, "consists of knowing your product thoroughly and neither overselling nor underselling your customer. In other words, in the line of machinery I have been handling I have never attempted to sell a customer a trench excavator just because that was my line and the only thing I could offer him when he positively needed steam shovels. The same rule would apply to the mixer line. The salesman selling this equipment should be familiar enough with the contracting game and his product to advise his customer whether he should have two small mixers or one large one to produce the most profit on the job. Salesmen lose customers for their concern as well as the prestige of their house in the contracting field by either overselling or underselling the purchaser. This phase of salesmanship has been properly termed a 'curse'." Mr. Greetham represented the Buckeye Traction Ditcher for

four years before entering upon his three-year engagement with P. & H. He modestly claims the United States as his territory; and, believe us, he covers it well. His hobby is talking motor trucks with old man Dickens of this publication. He is

ARTHUR W. GREETHAM.

one of those rare salesmen who not only Sunday at home but who go to church. He has only one child, but says, "Look at that one!" The little lady is here pictured with her daddy.

Here is a sketch of a veteran salesman in action. He has the contractor admitting that the Smith Low-Charging Mixer is the best ever. This is a typical pose and situation in the business life of Thomas B. Burnite, 523 Boston Building, Denver, Colo. He has represented a lot of lines and for a long time. His service record is: T. L. Smith Company, seven years; Smith Engineering Works, seven years; Erie City Iron Works, nine years; John F. Byers Machine Company, one year;

THOMAS B. BURNITE.

The Parsons Company, six months; Chicago Pneumatic Tool Company, five years; Kimball Elevator Company, seven years; Toledo Bridge and Crane Company, five years, and Spencer Turbine Cleaner Company, five years. He covers Colorado, Wyoming and New Mexico. These are sizable parcels of land lying west of New Jersey. His hobby is selling contractors equipment. The pen sketch was made by Frank Finch, the famous cartoonist of the Denver Post and the Kansas City Post. Burnite says his stenographer has more class than the old bird Finch has shown in the sketch.

Yes, they have hustling salesmen on the other side of that imaginary line dividing us from our Canadian cousins and friends. Mr. Douglas Robb, of Winnipeg, Manitoba, is that kind of salesman. Can ony one douht it when they look at this picture showing him at the wheel of his 1909 Ford, which

DOUGLAS ROBB.

he admits is the oldest car in Manitoba? He is a star salesman of the first magnitude and handles London concrete mixers, domestic contractor's equipment and Condor belting. He travels from Port Arthur, Ontario to Edmonton, Alberta. He is a great fisherman—fish mad, his friends say. He built himself a log fishing lodge on Crystal Lake, Ontario, and tries to take all his customers fishing.

George Entrekin, of Pittsburgh, Pa., has learned many things in the course of his long and more or less eventful life. He says that the majority of salesmen have always been under the impression that they know more than their contractor customer and even the college bred engineer, and have had many sad awakenings. Mr. Entrekin is shown at the right-hand flag pole in the picture—he calls this picture "Looking them over." These boys are not all his sons. Five of the group have enlisted, and two are already in France. To the left of the group is another kind of scene, the title of which

GEORGE ENTREKIN

is "Her'n." Two weeks every December he spends in the mountains of Pennsylvania, hunting deer and bear—on the square deer. He usually takes some of his competitors along on these trips. He finds them to be the very best of friends, as while they lie about his goods they refuse to lie about him. He has had much practical experience with both steam and

internal combustion engines, also electric lighting plants. His friends call him an expert, though he denies the allegation. He hasn't reached the half-century mark yet, but the last figure of his age is twice the first. He had twelve years in the theatrical business, four short, pleasant years with the Fairbanks Company at Pittsburgh and ten years (plus) with the Standard Scale and Supply Company, of Pittsburgh. Since Oct. 1 he has been located at 605 First National Bank Building, Pittsburgh, and has associated with him able and capable men, experts in their line, embracing scales, contractors' and road machinery, and one especially well educated on heavy motor trucks. The selling corporation is known as the Entrekin Company, at your service.

Personal Items

The roster of men in Companies B, C and D of the 108th Engineers (1st Ill.), U. S. N. G., who formerly held civilian engineering positions, is here given with their present rank and their former positions:

Company B—Capt. Benjamin C. Allin (civil engineer, C., R. I. & P. Ry.); Joseph C. Arey (electrical engineer, Cadillac Auto Co.); Walter J. Barrow (rodman, Santa Fe Ry.); Sergt. Clarence R. Braun (mechanical engineer, J. G. Braun, Chgo.); Charles F. Butler (electrical engineering student); Francis A. Cole (draftsman, Sargent & Lundy Co.); August T. Drom (construction division, Wisconsin State Highway Dept.); Alfred R. Edwards (chem. eng. student); Corp. H. W. Eshelman (arch. draftsman); Walter R. Faust (architect, N. Dunning); Harry S. Cutmore (valuation engineer); Louis F. Fisher (student, Armour Inst.); Corp. Albert G. Ford (asst. engr., W. E. Deutchler, Aurora, Ill.); Sergt. R. H. Forsythe (struc. draftsman, Universal Portland Cement Co.); Lewis Harper (draftsman, Rock Island Ry.); B. J. Herman (arch. estimator); First Lieut. L. J. Hughes (civil engr., C., R. I. & P. Ry.); Corp. E. J. Tilfoyle (eng. student, Armour Inst.); Corp. W. B. Kirkland (elec. draftsman, Western Elec. Co.); H. A. Long (civil engr., C. & N. W. Ry.); Corp. Oscar Laster (civil engr., Universal Portland Cement Co.); H. B. McClintock (civil engr.); Corp. J. McGee (eng. dept., C., R. I. & P. Ry.); Corp. Elmer H. Meinke (civil engr., C., B. & Q. Ry.); W. B. Mercer (draftsman, Gifford-Wood Co., Chgo.); L. V. Okerberg (draftsman, Poole Bros., Chgo.); P. A. Olson (draftsman, Ronneberg & Pierce, Chgo.); J. G. Ritter (arch. engr., Geo. A. Fuller Co.); L. H. Robertson (civil engr., I. C. Ry.); E. L. Salisbury (inspector, M. C. Ry.); Sergt. W. J. Savage (student, Armour Inst.); H. G. Schultz (draftsman); N. J. Schutz (eng. student); Geo. Shervington (civil engr., General Concrete Const. Co., Chgo.); A. L. Smith (mech. engr.); Sergt. F. E. Smith (eng. draftsman); Corp. A. F. Stoal (eng. draftsman); Sergt. G. S. Swanson (mech. engr.); Corp. G. B. Vernier, Jr. (mech. draftsman); T. R. Wirvl (elec. engr.); R. V. Williams (elec. engr.); K. R. Wilson (engineer, Stone & Webster); H. M. Wood (civil engr., Chgo. Union Sta. Co.); R. E. Zimmerman (draftsman, C., B. & Q. Ry.).

Company C—Capt. Harmon Laughlin (civil engr., Ewing & Allen, Chgo.); Second Lieut. Harry L. Hudson (engineer); First Lieut. Harry A. Roe (mech. engr., Pullman Co.); Chas. E. Cameron (draftsman, Crane Co.); J. Campbell (Ry. const. engr.); Geo. M. Davis (civil engr., U. S. Govt.); L. J. Hague (asst. engr., Vermont Steel Co.); Sergt. H. V. Hume (asst. engr., V. B. Roberts); C. R. Jones (surveyor, Westinghouse-Church-Kerr Co.); James Koca (auto draftsman); E. A. Martin (asst engr.); Sergt. N. A. Meyer (civil engr., C. & N. W. Ry.); Sergt. D. R. Norris (valuation engr., I. C. Ry.); Corp. L. E. Perry (draftsman, Cont. Bridge Co.); L. A. Schalk (draftsman, Western Elec. Co.); Sergt. R. H. Smith (draftsman, Chgo. Telephone Co.); R. Stoesser (draftsman); R. E. Sullivan (const. engr., Leonard Const. Co.); A. A. Weston (asst. engr., C. & N. W. Ry.); L. H. Yurachek (draftsman).

Company D—Capt. Albert H. Sheffield (const. engr., Am. Terra Cotta Co.); Lieut. Leon R. Gurley (est., Am. Terra Cotta Co.); Lieut. Frank R. Stauffer (const. engr., C. P. R. R.); L. H. Abbott (draftsman); E. M. Bauernfiend (draftsman); W. J. Borucki (draftsman); N. C. Bradley (draftsman); Sergt. Clinton S. Darling (civil engr.-editor); Sergt. G. E. Dyson (const. engr.); Corp. R. F. Fields (civil and Efficiency engr.); Sergt. C. J. Frankel (sales engr.); R. V. Gustafson (draftsman); Paul Hosman (const. engr.); F. J. Impey (draftsman); H. W. Julison (draftsman); J. I. La Velle (const. engr.); W. L. McNamara (mech. engr.); W. Madsen (draftsman); Clyde Maze (map draftsman); Geo. Niemy (draftsman); W. G. O'Neil (const. engr.); Sergt. W. M. Parkhurst (eff. engr.); Sergt. H. C. Peters (architect); P. B. Rudolph, Jr. (supt. of const.); W. A. Schmidt (eng. student.).

Frank M. Gallagher, of Butte, Mont., has been appointed engineer of the Montana Public Service Commission at Helena.

F. M. Randlett, formerly of Lawrence, Mass., has been appointed chief engineer of the Water Bureau of Portland, Oregon, to succeed D. D. Clark, who left the position because of ill health, after 20 years of conspicuous success. It was under him that the present $14,000,000 system was developed. Mr. Randlett has been principal assistant engineer to Mr. Clarke for 11 years.

J. F. Mangold, city engineer of Grinnel, Iowa, and professor of civil engineering at Grinnel, has accepted a like position at the South Dakota State School of Mines at Rapid City, S. D.

Maj. Henry L. Bowlby, formerly state highway engineer of Oregon, has been appointed senior highway engineer of the office of public roads and rural engineering, Department of Agriculture. His headquarters will be in Denver, Colo. For the past two years he has engaged in private practice as a consulting highway engineer.

C. E. Leonard has been appointed city engineer of Austin, Texas, to succeed M. C. Welborn, who resigned to take a position with the State Highway Commission. Mr. Leonard was bridge engineer of Austin for a year and a half and built about $75,000 worth of reinforced concrete bridges. When this work was completed he was made paving engineer, from which position he was promoted to his present position.

H. Walter Leavitt has been appointed testing engineer of the Maine State Highway Commission and also assistant professor of civil engineering at the University of Maine, Orono, Maine.

J. T. Gear has been appointed city engineer of Puyallup, Wash. He was formerly city engineer of Kelso.

J. W. Greer has been appointed city manager of Bryan, Texas, succeeding W. Pipperman, who resigned to enter the army.

Arthur F. Shuey was recently appointed superintendent of water works at Tampa, Fla.

Miss Esther Jack has been appointed city engineer of Williston, N. D., to succeed E. R. Evans. She is an engineer graduate of the state university.

Bituminous Surfacing for Plank Bridge Floors

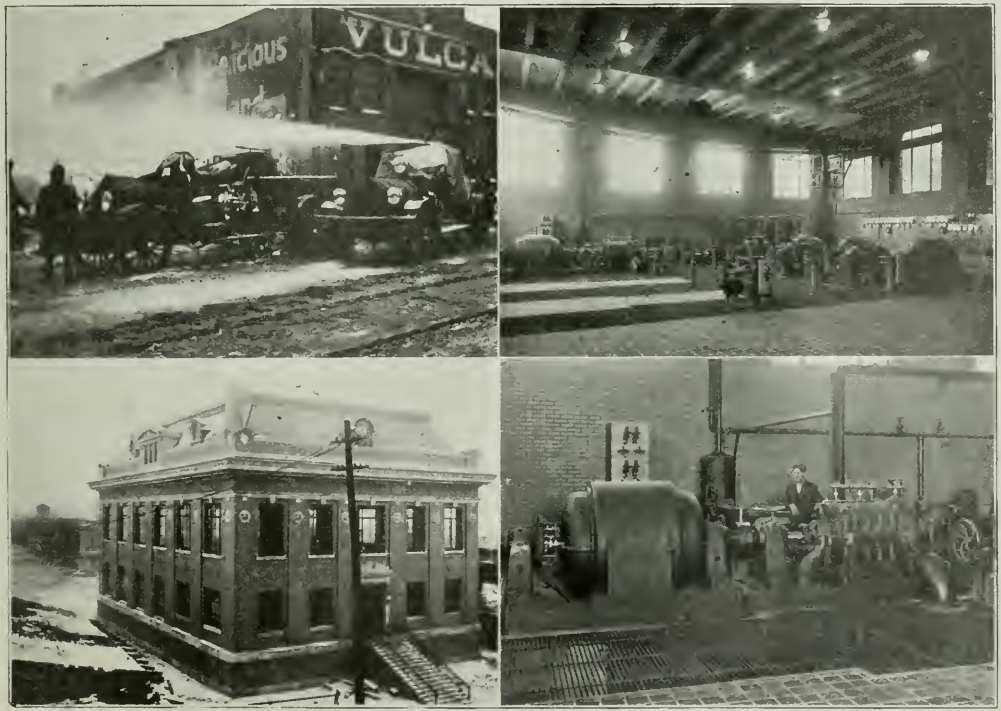
The Minnesota State Highway Commission is advocating the use of a bituminous surfacing for plank bridge flooring. It is claimed for this bituminous surfacing that it may be easily applied, that it lasts as long as the average plank floor and costs only one-third as much. The great objection to the old-time wood bridge floor is the cost of frequent replanking

Fire Engineering

The Design, Construction and Operation of Toledo's New High Pressure Fire Protection System

By W. J. Sherman, of the W. J. Sherman Company, Consulting Engineers, Toledo, Ohio

The practically total destruction by fire of the property within the congested value districts of Boston, Chicago, San Francisco and Baltimore because of inadequate fire protection, together with the recognized advantages of lower insurance premiums, has resulted in the establishment of special fire service systems separate and distinct from the domestic service systems for numerous American cities, including New York, Philadelphia, Baltimore, Cleveland, Winnipeg, Toledo and Boston.



VIEWS OF NEW HIGH PRESSURE FIRE PROTECTION SYSTEM, TOLEDO, OHIO.

The High Pressure Mains

An ordinance appropriating $41,570 for the city's portion of the high pressure mains was passed Nov. 21, 1910, and on March 23, 1914, the city council appropriated $20,000 for the purchase of the site for the pumping station, and on May 25, 1914, $180,000 for the station itself.

Under authority from the council there were laid 22,500 ft. of 10-in., 12-in. and 16-in. class "G" extra heavy cast iron pipe in the principal business district bounded on the north by Cherry street from the Maumee river to Superior street, thence south to Jackson avenue, thence west to Michigan street, thence south to Monroe, east to Ontario, south to Washington and east to St. Clair, north to Monroe and east to the Maumee river, embracing an area of 160 acres and protecting approximately 200 acres.

Contracts and Cost

In October, 1914, the writer was engaged by the city to prepare plans and specifications for the pumping station and its equipment, and about May 1, 1915, contracts were awarded as follows, viz:

Substructure—M. F. Conner.

Superstructure—The A. Bentley & Sons Company.

Equipment—The Arrow Engineering Company.

The total cost of the fire service pumping station was well within the appropriation of $180,000, notwithstanding the fact that a third story was provided for the structure since the appropriation was made. This was done for the double purpose of improving the appearance architecturally and also of providing 5,800 sq. ft. of floor space for some one of the city departments. This space has recently been occupied for office purposes by the water works department.

Equipment

The station is intended to be a model one in every respect. It is located on the Maumee river, close to the Maumee bridge.

It is 65 x 90 ft. in plan, with bearing walls of brick and reinforced concrete floors.

The initial installation called for four motor driven, five stage Allis-Chalmers centrifugal pumps, each capable of delivering 2,000 gallons per minute against a pressure of 300 pounds per square inch at a speed of approximately 1,500 r.p.m.

There are blank spaces for two additional pumps. The supply comes direct from the river and the distribution system is entirely separate and distinct from that which carries the filtered water for domestic use.

The motors for driving the pumps are of the alternating current, slip ring induction type; three phase current at 25 cycles and 4,000 volts is supplied for the operation of these motors. The normal rating of each motor is 550 horse power. Current is furnished by the Toledo Railways and Light Company for both A. C. and D. C. circuits, though an emergency direct current motor generator set has been installed.

Meters have been placed in each of the two 16-in. discharge lines, leaving the station with recording rate of flow and total flow gauges.

All important valves are motor operated. A twelve-panel switchboard of Blue Vermont marble has been provided.

The oil switches for the control of the high tension current have been placed in the pipe gallery. Basement drainage is taken care of by means of a vertical sump pump and motor, while for emergency use the larger pumps can take suction direct from the sump.

The high pressure system is kept full of water at all times ready for instant use.

The operator at the fire service pumping station is kept informed of the progress of fires and the requirements of the fire department by telephone and by the fire alarm telegraph system.

Insurance

The Ohio Inspection Bureau classifies municipalities of the state according to their fire fighting facilities. There are ten classes, viz:

Nos. 1, 1½, 2, 2½, 3, 3½, 4, 4½, 5, 6.

Cleveland is the only city in the first class, Cincinnati the only one in class 1½, Columbus the only one in class 2, and Toledo the only one in class 2½, while class 3 comprises Lima, Hamilton, Dayton and Youngstown.

During a general rerating of this city in 1914 the residential districts were transferred from class 2½ to class 1, and within three months after the completion and satisfactory testing of the system it was expected that the property in the congested district would be transferred from class 2½ to class 2.

Tests

The equipment and pipe lines of the high pressure system were subjected to satisfactory tests under operating conditions for several weeks preparatory to transferring the plant from the contractors to the permanent operating force to be maintained there by the city.

The Future

It is proper to call attention to the fact that the pumping capacity of the station, viz., 8,000 gallons per minute from the four pump units already installed with 4,000 gallons per minute additional from the two future pump units, foundations and piping for which are now ready, is sufficient to care for a much larger central territory than the 200 acres protected by the existing system of high pressure mains, and therefore the city should soon undertake the construction of additional mains designed primarily to reinforce the existing system and so located as to provide for territory not now protected by high pressure.

The pumping station is designed for a much larger capacity than the distribution system, and the latter should be enlarged as soon as practicable.

OBITUARIES

William Walter Marr, Chief State Highway Engineer of Illinois, was born in 1876, in Chicago, Ill., of an old American family. He was educated in public and private schools in Chicago and at the University of Notre Dame at South Bend, Ind., graduating from that institution as a Bachelor of Science in 1895, and taking post graduate work in 1896, for which he received the degree of C. E.

In 1897 he entered the employ of the city of Chicago as an assistant engineer, and for several years was employed in various capacities in charge of bridge repairs, water supply, harbor work and tunnel construction, under the general charge of the city engineer.

In 1902 he became Division Engineer for the Board of Local Improvements of the city of Chicago, being in general charge of street paving work for the West Side of Chicago.

In 1908, together with Paul E. Green, he formed the present civil engineering firm of Marr, Green & Company of Chicago.

In 1914 he was appointed by Governor Dunne, a Democrat, as chief state highway engineer, and in 1917 was reappointed to that position by the incoming Republican governor, Lowden. Under his charge the State Department of Highways was practically reorganized and placed on thoroughly efficient basis. Many millions of dollars of work was planned and constructed. At the time of his death he was engaged on far-reaching plans providing for the expenditure of some $60,000,000 for a statewide improvement of roads in Illinois.

He was a member of the American Society of Civil Engineers, of the Illinois Society of Engineers and Surveyors and of the Springfield Engineers' Society.

Mr. Marr had made a special study of municipal paving and country highways. He was widely recognized as an expert of the highest class in these lines, and his advice was in constant demand.

He had made a magnificent record in public office and his reappointment to the position by Governor Lowden was recognition of this fact. He was widely known in Illinois and adjoining states for his splendid technical and executive ability, and was in continuous request as a speaker at good roads conventions and similar movements.

He died October 3, 1917, and is survived by a widow and four children.

Coming Conventions

CITY MANAGERS' ASSOCIATION—Annual meeting at Detroit, Mich., Nov. 19-24. Sec'y, W. L. Miller, City Manager, St. Augustine, Fla.

NATIONAL MUNICIPAL LEAGUE—Annual meeting at Hotel Statler, Detroit, Mich., Nov. 21-24. Sec'y, Clinton Rogers Woodruff, 703 North American Bldg., Philadelphia, Pa.

VIRGINIA GOOD ROADS ASSOCIATION—Annual convention at Richmond, Jan. 15-17, 1918. Sec'y, C. B. Scott, Richmond.

FIRST CHICAGO CEMENT MACHINERY AND BUILDING MATERIAL SHOW—Supersedes annual Chicago Cement Show. To be held under auspices of the National Exhibition Co., 123 West Madison St., at the Coliseum, Feb. 6-13, 1918.

No. 6 — Vol. LIII.

Municipal Engineering

Chicago, Ill.
December, 1917.

Design, Construction, Operation and Maintenance of all Public Works

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For the Amendment of Priority Order No. 2.

Certain features of Priority Order No. 2, promulgated by the Federal Government on October 27 and taking effect on November 1, have such possibilities for working far-reaching harm that they should be withdrawn. Briefly, the order forbids the use of railway gondola cars for: Hauling materials and supplies, other than coal, for the construction, maintenance or repair of public or private highways, roadways, streets or sidewalks; materials and supplies, other than coal, for the construction, maintenance or repair of theaters or other buildings or structures to be used for amusement purposes; material and supplies, other than coal, for the manufacture of pleasure vehicles, furniture or musical instruments; and, passenger vehicles, furniture and musical instruments. "Which articles," reads the order, "the undersigned (Robert S. Lovett) finds not essential to the national defense and security."

Some of the "articles" enumerated, such as places of amusement and musical instruments, are clearly not essential to national defense and security, but can the same be said of public highways? We think not. On the contrary, we hold that the rapid improvement of public highways is in the last degree essential to national defense and security, when those terms are broadly interpreted. The order classes roads with luxuries and amusements, whereas a modern road is distinctly utilitarian, although in improving living conditions it does incidentally give pleasure to its users.

The people of this country are in a road-building mood, after years of patient and expensive educational effort with that end in view, and it is questionable whether it is wise to issue an order of this kind, which is likely to plunge road building in this country back into the dark ages again. That the people want better roads is conclusively demonstrated by the number of road bond issues being voted in all parts of the country. If the war lasts two years and this order remains in full force road building will be set back a quarter century or more. This is a bad national prospect.

The suspension of road building, or its very serious curtailment, will adversely affect numerous important industries which have been generous supporters of the government's war policies and which have cheerfully paid war taxes and bought war bonds. Many of these industries were relying on road construction and repair work for enough business to keep them running during the war. To them this order is a very serious one indeed. Will there be other orders equally serious to other industries? If so, who will float the war loans?

But important as the foregoing considerations are, they are by no means most important. So far as the adverse effects on individual firms is concerned, these might be overlooked in the interest of the greatest good for the greatest number, but in times like these we must make very sure of that "greatest good."

It is interesting to consider the effect of this order on public opinion in enemy countries. When news came to this country that, despite the war, Germany was going on with the building of subways in Berlin the effect on public opinion in this country was marked. People reasoned, and rightly as events since have proved, that if Germany could carry on such an important constructional activity as subway building, conditions in that country could not be as bad as represented. Conversely, will not the news of the curtailment of road building by government order in this country create the impression in Germany that conditions are not sound here? And will not this tend to prolong the war? In our opinion both questions must be answered in the affirmative.

Many there are who hold with us that the rapid improvement of public highways is essential to national defense and security. Numerous conventions of business men have endorsed pretentious road building programs. The recent war convention of the Chamber of Commerce of the United States adopted by acclamation resolutions urging that the prompt improvement of public highways is important and should be forwarded in every proper way.

Not long ago President Wilson said: "It is perfectly obvious that you have got to have an intricate and perfect network of roads throughout the length and breadth of this great continent before you will have released the energies of America." The allies are depending on the energies of America. Unless they are released and given full play there is grave danger of losing the war. Road construction is, therefore, imperatively requisite to national defense and security.

The railroads are unequal to the demands made on them. This fact lead directly to the promulgation of the order under discussion—to release cars for other uses the shipment of road-making materials has been forbidden. Motor truck freight highways are proving their worth on such long runs as from Akron, Ohio, to Boston. We must have more of them as fast as they can be built. Road construction is almost as essential as ship construction—let us not overlook that fact.

German finance is the real wonder of the war. How has that country been able to float so many big war loans? By keeping the money in circulation and withdrawing it uniformly at many points as water is drawn from taps in a circulatory pipe system. Priority Order No. 2 is in effect a cutting of the pipe line. Fortunately there is strong probability that the embargo on road materials will be lifted before spring. Certainly it should be. Engineers and business men, in their conventions, should adopt resolutions looking to this end and should use their influence to have created a National Highway Board of the Council of National Defense—a board better qualified and with more time to pass on such matters than the present Priority Board.

Special Contributors for 1918

Published as an insert in this number of MUNICIPAL ENGINEERING is a list of special contributors to this journal for the year 1918. The list is made up wholly of names well known to readers of engineering literature. There will be at least one article from each of these contributors. One author will write a series of twelve articles on road construction, another a series of six articles on water works maintenance and operation, and while the other authors have promised to write but a single article each it is probable some will write more than one article.

The claim is frankly put forward that this is the greatest list of special contributors ever announced by an engineering journal. That claim is made in all sincerity and, as the lawyer puts it, "without fear of successful contradiction." Those who are at all familiar with the literature of the profession know these men as writers of constructive articles. Each man will write on his specialty.

These special articles are in themselves sufficient to make MUNICIPAL ENGINEERING of 1918 indispensible to all who are interested in the design, construction, operation and maintenance of public works. By public works we mean works designed by engineers and built with public funds. This includes, of course, work in the county, state and nation as well as in the city.

The articles will be addressed to workers in every branch of the field covered by this periodical, while some will deal wholly with design, others will deal wholly with construction, and still others will deal wholly with the problems incident to the maintenance and operation of public works. The interests of all classes of our readers will be kept in mind.

Naturally there will be many other contributors to MUNICIPAL ENGINEERING of 1918 than those announced in this issue. Those announced have already agreed to write articles for us; of course, many others will do so from time to time.

Go On Planning to Build

There are many obvious reasons why planning for public works construction should move forward steadily at this time. It is true that the end of the war is not in sight but it is likely the end will come suddenly when it does come. In that event there is likely to be a construction boom in this country and the city that is far advanced in the planning of its public improvements will be in a strategic position as compared with the city that must rush through its period of planning.

Ordinarily too little time is devoted to planning. Usually there is a long period of procrastination, followed by a short period of hectic haste in planning, and then the period of construction. Errors and miscalculations of all sorts creep into plans and projects prepared in great haste, and cities are a long time paying for their mistakes of this nature.

In general it may be said that cities that plan in haste repent at leisure. Now is a good building time and a great planning time. Plans can now be made at a minimum of expense and every city should plan its improvements for several years ahead so as to be prepared for every contingency that may arise. It is a patriotic duty to plan now just as much as it may be a patriotic duty to build when the ending of the war releases millions of men who can be utilized to their own and the public advantage in public works construction.

Motor Truck Freight Highways

Interest in motor transportation on highways is advancing in leaps and bounds. The existing transportation system has been unable to meet the demands laid upon it by the heavy war traffic. The railroads simply cannot move the freight that is brought to them. They are actually calling for help! After years of lobbying against other forms of transportation this new attitude on the part of the railroads is proof positive that they are unequal to the transportation demands of the times. Railroad men are even speaking a good word for their traditional enemy, the waterway!

A few days ago Hale Holden, President of the Chicago, Burlington and Quincy Railway, said: "We must make greater use of waterways, electric lines and motor trucks wherever practicable means can be developed to accomplish this, and no better time than the present can be found to make the experiment."

J. Denny O'Neil, Pennsylvania State Highway Commissioner, is authority for the statement that there are localities in Pennsylvaniia where it costs more to haul the produce to market, because of bad roads, than it does to transport it from America to France. What a striking illustration of the need of good freight highways, capable of handling motor truck traffic!

In speaking recently of transportation as one of the necessities of our national life Mr. S. M. Williams, of Lima, Ohio, said: "In former times in thinking of transportation our minds immediately went out to the railroads or waterways. The highways were not considered except as a matter of convenience for individual communities through which they traversed and owing to the miserable and unreliable conditions of the highways in many sections of the country, we have been paying a penalty of over two hundred and fifty million dollars per year in excessive cost for transporting our agricultural products alone from farm to market or shipping point."

Business men in all lines are endorsing the construction of motor freight highways as a necessary and sufficient form of reinforcement to our present transportation system. A bill is now awaiting Congressional action which proposes giving to the Postoffice Department power to establish a special motor truck collection system, with the object of effecting a more prompt and economical handling of foodstuffs between farm and consumer. Of course, roads capable of carrying heavy motor vehicles are requisite to the successful working of such a plan.

Bacon Was Right

In his preface to Maxims of the Law Sir Francis Bacon wrote: "I hold every man a debtor to his profession; from the which as men of course do seek to receive countenance and profit, so ought they of duty to endeavor themselves by way of amends to be a help and ornament thereunto." Yes, Bacon was right. The same thought, stated in modern but not less ornate English, was expressed a few years ago in the Code of Ethics of the Western Society of Engineers. One of the best, and one of the best recognized, means of "making amends" to the engineering profession is by exchanging knowledge through the engineering periodical. It is a real pleasure to acknowledge the cooperation of engineers in the making of the modern engineering journal—most engineers acknowledge their debt to the profession and take this means of paying it.

Methods Employed in the Construction of a Siphon Tunnel Under the Milwaukee River.

By A. L. Golinkin, Engineer Inspector, Sewerage Commission of the City of Milwaukee.

THE siphon tunnel discussed in this article is one of three large, concrete, double-deck siphons included in the construction of the new intercepting sewer system being built for the city of Milwaukee. Wis. In addition to the construction of the actual intercepting sewers, a complete disposal plant is also to be built, the entire project being carried on under the engineering supervision and direction of the Sewerage Commission of the city of Milwaukee. All work on this tunnel is being done by the John F. Casey Engineering and Construction Company of Pittsburg as part of a contract awarded them in April, 1916. The following discussion is limited to a general description of the siphon tunnel and a review of the constructional methods used in driving and concreting, but contains practically no data on design.

point 128 ft. west of the west bank of the Milwaukee River and is carried to a riser shaft situated at the corner of Detroit and Broadway streets, a distance of 604 ft. from the east bank of the river and a total distance of 1,015 ft. from the drop shaft.

Compressed air was delivered to the tunnel immediately after the drop shaft was sunk and was used continuously thereafter. A maximum pressure of 21 lbs. per square inch was required during the early stages of the work, particularly when the eye of the tunnel was being cut, while an average pressure of 14 lbs. was sufficient for the remainder of the work.

The power house constructed on the job contains three complete motor-driven compresser units, a steam boiler for the steam pumps, and a hydraulic pressure machine. The

CONSTRUCTION VIEWS ON MILWAUKEE SEWER SIPHON TUNNEL UNDER RIVER. FIG. 1—HITTING DAYLIGHT—SHIELD JUST EMERGING AT RISER SHAFT—NOTE KEYBOARD AND TIMBERING. FIG. 2—HOUSING OVER DROP SHAFT. FIGS. 3 AND 4—METHOD OF DRIVING INNER SET OF 50-FT. BY 14-IN. LACKAWANNA STEEL PILING AT DROP SHAFT.

General

The intercepting sewer system is of the dual type. For purposes of general design the city was divided into four watersheds, each drained by one of the four watercourses in Milwaukee. Since each of these areas included lands too low to permit sewage to be delivered to the site selected for the disposal plant and also areas that would permit a gravity flow to the plant, the high and low level intercepting system was decided upon. At the point where the sewage is delivered to this siphon tunnel the high-level sewer has a diameter of 72 in., and the low-level sewer is 48 in. in diameter.

The sewage is delivered to the siphon at a drop shaft located at the corner of Fowler and West Water streets, at a

Watson Stillman hydraulic machine was driven by a 30 h. p. motor, its accumulator carried weights from 10 to 15 tons and was capable of furnishing a pressure up to 5,000 lbs. per square inch.

The Shafts

The site at West Water and Fowler streets being definitely chosen for the sinking of the drop shaft, work was commenced by the contractor on June 27, 1916. The shaft is rectangular in shape, has bottom dimensions of 23 ft.x23 ft. and is 16 ft. square on the bottom. It is excavated to a depth sufficient to give the top of the tunnel an elevation of minus 39. The material encountered at first was sand and stiff clay, but the character of the ground encountered at lower depths and

determinations made by several borings under the Milwaukee River indicated that below minus 39 it was probable that sand and gravel would constantly occur. To avoid tunneling in this material permission was granted the contractor to change the elevation of the top of the tunnel from minus 50 to minus 39.

The shaft was driven by means of Lackawanna steel sheathing. After the first set of 28-ft.x14-in. sheathing was placed, excavation was carried on to a depth of — 18.00, the

CONSTRUCTION VIEWS OF MILWAUKEE SEWER SIPHON TUNNEL. MIXER AND HOPPER AT TOP OF RISER SHAFT—OPERATING SHIELD IN TUNNEL—SECTION OF ARCH JUST INSIDE OF AIR LOCK.

second set of 50-ft.x14-in. sheathing was then arranged to form a complete box 16 ft. square, and each piece was driven separately and in place, insuring a tight, compact job. When excavation had progressed to within several feet of grade, grout pipes were driven in and a mushroom bottom grouted at the end of the sheathing, after which excavation was continued to grade and a 6-in. concrete slab poured. A cradle for the hydraulic shield was now constructed on the bottom of the shaft and the shield erected into place. A timber deck was then set several feet above the top of the shield, and the upper part of the shaft was immediately concreted in, all the steel sheathing being left in place. Air locks were now set in, compressed air was supplied and the eye for the tunnel was cut through the steel.

The inside dimensions of the riser shaft, which will include a valve chamber, is 16-ft.3-in.x17-ft.9-in. and was driven by the use of three sets of timber sheathing. The outside set was made up of 4-in.x10-in. timbers driven to a depth of 9 ft. This was followed by a box of 4-in.x8-in. timbers driven 20 ft., and the inside timbers were 4-in.x8-in. and 20 ft. long. After a 10-in. slab was placed on the bottom of the shaft, forms for the riser section of the 36-in. sewer were put in and concrete was poured to a depth of 6 ft. No more work was done on this shaft until the shield emerged through the sheathing, after which the wooden forms for the arch transition section were set. This transition section converts the arch section (or high-level sewer) into two 60-in. circular risers, one of which will connect through a "Y" special into the 60-in. high-level sewer on Broadway street. The other 60-in. riser of the transition section will be temporarily capped and made available for future connections. The 36-in. riser makes connections with the low-level concrete 68-in.x49-in. sewer on Broadway.

During all driving operations a 2-in. Nye pump was able to handle all seepage in the riser shaft, while a 3-in. Nye pump was required for the drop shaft.

Driving the Tunnel

The 1,015-ft. tunnel which connects the drop and riser shafts was driven circular in shape, with an outside diameter of 13 ft. The floor of the tunnel at the drop shaft heading is 49.09 ft. below water level, whence it slopes up at a grade of .14 per cent to a point beneath the east shore of the Milwaukee River, where the grade is changed to 3.2 per cent, and continues at this grade to the bottom of the riser shaft, the elevation here being 28.65 ft. below the river water level.

The tunnel was excavated by means of a hydraulic shield, which was 9 ft. 6 in. long and built of steel. Motive power was applied to it through 14 hydraulic jacks, each designed to carry a working pressure of 6,000 lbs. per square inch and having an extension of 22 in. Hydraulic pressure varying from 2,800 to 5,000 was sufficient to push the shield at all points in the tunnel. After 100 ft. of tunnel had been driven a steel airlock of two chambers was constructed and securely concreted into place.

As the shield was pushed along 6-in.x8-in. hardwood and 4-in.x8-in. yellow pine cants were placed the hydraulic jacks were pushed directly against them. This resulted in a very tight job of the timbering. The muck was shoveled into ½-yd. collapsible cars, which were pushed out through the material lock, led onto a hoist, lifted up and dumped into a hopper on top of the shaft and then delivered into auto trucks. The shield carried a platform placed on springline and a timber platform at the same elevation was built in the tunnel in successive sections as the shield was pushed along. Upon this platform the tracks were laid, which greatly facilitated the removal of muck by allowing the cars to be led directly into the shield. The shield was also divided into quadrants, two openings being below the platform and two above. The two miners in the lower part of the shield threw their muck onto a small timber platform, which was set within one foot of the bottom of the tunnel and carried along close to the shield; here it was relayed by two muckers to the springline platform and then thrown into the cars. The miners in the upper part of the shield dumped the muck directly into the cars, or threw it onto the tunnel platform, from which it was thrown into the cars.

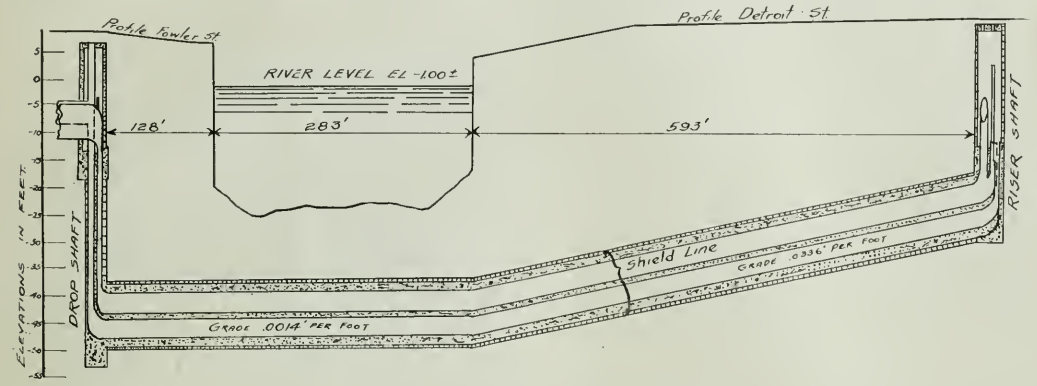
After each push a check was made upon the shield by the engineer and data of the following nature were furnished the shield operator: (1) Position of shield with respect to center line of tunnel; (2) horizontal lead; (3) vertical lead; and (4),

grade. With this information the shield operator could constantly adjust the position of the shield.

After the tunneling had progressed to a point some 900 ft. from the drop shaft and the concrete had been carried up to station 8+91, a steel bulkhead was placed in both the arch and circular sections, a door being left in the arch so as not to interfer with the operation of the muck cars during mining.

shoveling, and by keeping two spaders continually below the platform a well-tamped concrete job was secured. A 4-in. galvanized iron pipe was carried along between the timbering and the forms, which succeeded in draining off the water.

In concreting the arch, hydraulic pressed steel forms were used. Each set of forms making an arch section of the correct dimensions, consisted of eight plates and one pair of pressed



PROFILE OF MILWAUKEE SIPHON TUNNEL.

A timbered box tunnel (a monkey drift) was now started from the riser shaft and carried in towards the shield. Meanwhile driving with the shield from the inside was continued, and when only 18 ft. of the marsh clay was left between the heading of the monkey drift and the cutting edge of the shield a material loss of compressed air occurred. The bulkhead door was now closed, the monkey drift was driven into the shield and the shield was driven straight ahead, completely "biting off" the smaller tunnel. When the shield finally reached the riser shaft the jacks were removed, the platform and pockets cut away, and the shell was allowed to remain in the ground.

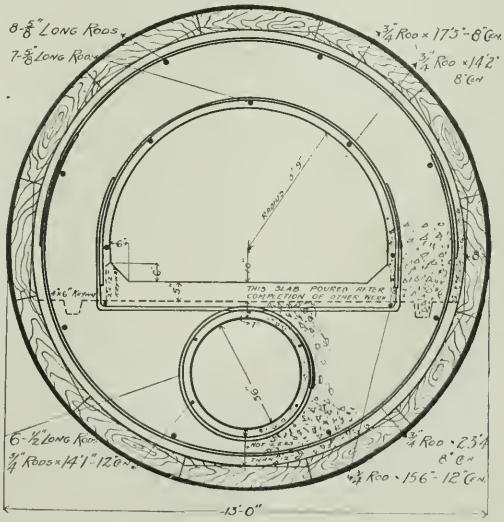
The character of the material encountered varied, although the greater portion of the last 600 ft. was marsh clay. For a considerable distance underneath the river large quantities of running sand and gravel were continually met with. This necessitated a constant breasting of the face at the cutting edge of the shield, but when the end of the river was reached and a change of grade occurred the shield gradually rose out of the sand into a uniform bed of marsh clay. Practically all work on the siphon tunnel was carried on 24 hours per day, employing three shifts of 17 men each. One day's mining and timbering averaged from 10 to 15 ft.

Concreting

The concrete work on the siphon tunnel was done in three distinct stages; first, the bottom was placed, entirely enclosing the 36-in. sewer, the top of the pour being 7 in. from the top of the circular forms; the arch was then concreted in, and finally a 5-in. slab was laid along the bottom of the arch section, making the total distance from the top of the 36-in. sewer to the flow line of the upper sewer 12 in.

In placing the lower sewer, circular steel forms built in 4-ft. lengths were used. The sections for putting in the concrete were set in various lengths, usually 47 ft., and after the proper reinforcing steel was set the section was closed off by means of temporary timber bulkheads, on which were placed 4-in.x6-in. keys. Since the platform built during the mining operations was entirely clear of this bottom pour, the ½-yd. cars of concrete could be brought in upon it to the place immediately above the section to be concreted and the concrete dumped directly into place. This permitted a minimum of

steel ribs. The plates were made in 4-ft. lengths of varying widths and had steel facings with laminated wooden backs. The forms were set up in 16-ft. sections, most of the steel reinforcing being set before the form ribs were put up, and the sections were closed off with timber bulkheads similar to those used in the bottom. By putting up the wall plates in single


8-⅝" LONG RODS
7-⅝" LONG RODS
¾" ROD × 173'-8" C.M.
¾" ROD × 142' 8" C.M.
THIS SLAB POURED AFTER COMPLETION OF OTHER WORK
6-½" LONG RODS
¾" RODS × 141'-12" C.M.
¾" ROD · 23'-8" C.M.
¾" ROD · 156'-12" C.M.
13'-0"

CROSS-SECTION OF MILWAUKEE SIPHON TUNNEL.

rows the concrete could be conveniently placed, tamped and inspected. Except for the two top key plates, each row of plates was clamped in as soon as the concrete had reached the top of the preceding row, but in "keying up" each 4-ft. section was entirely completed before the next pair of key plates were put up. Two-in. grout pipes were placed through the concrete

in the top of the arch every 16 ft., grout being pumped through them after all the rest of the concreting was completed.

After the bottom sewer and arch were concreted the 5-in slab was placed. The surface on which the slab was to be laid was thoroughly cleaned and chipped and a rich mixture of concrete was placed through the entire length of the tunnel. The surface of the slab was carefully screeded and finished.

Except for the small section of tunnel adjoining the airlock, no concreting was done until the mining had progressed half way across the river, a distance of some 200 ft. Concreting of the bottom was then commenced and followed along about 100 ft. behind the shield. After the mining had progressed entirely across the river and the bottom section had been placed up to the same point, the shield work was entirely suspended and the arch section was concreted in. In placing this portion of the arch, work was started at a point about half way across the river and the concreting was carried on in both directions. The first 400 ft. of siphon tunnel was now completely concreted, except for the slab, and the mining was resumed. After this the concreting and mining were done alternately, each being carried on under the most favorable circumstances. The last 150 ft. of concrete work was done in free air, since that portion of the tunnel was open to the riser shaft; the remainder of the concreting was done, however, under compressed air.

A ½-yd. motor-driven mixer, stationed directly at the top of the drop shaft, delivered the concrete into collapsible cars, which were lowered by the shaft hoist, run through the material lock and into the tunnel. For the 150 ft. of open tunnel a mixer was placed at the top of the riser shaft and the concrete was delivered to the cars below by means of a chute. A 1:2½:4½ mix was used throughout.

Some Hints on Concreting in Cold Weather

During the first few days following the placing of concrete, alternate freezing and thawing at comparatively short intervals will damage it. The following suggestions relative to concreting in cold weather have been offered by the Portland Cement Association:

Although concrete which freezes before early hardening has been completed may not be permanently injured, if after thawing out it is not again exposed to freezing until hardened, protecting the concrete against possibility of freezing is best. Therefore it is necessary to so mix, place and protect the concrete that early hardening will be complete before the work is exposed to freezing temperatures. To do this:

(1) Sand and pebbles or broken stone used must be free from frost or lumps of frozen materials.

(2) If these materials contain frost or frozen lumps, thaw them out before using.

(3) As cement forms but a relatively small bulk of the materials in any batch of concrete, it need not be heated.

(4) Mixing water should always be heated.

Although adding common salt of mixing water will prevent freezing of concrete that has not hardened, there is a limit to the quantity of salt which may be added if the final strength of the concrete is not to be affected. Salt simply lowers the freezing point of the mixing water; it does not supply what is most needed—heat and warmth. It delays, instead of hastens, the hardening of the concrete.

Sand and pebbles or broken stone and mixing water must be heated so that the concrete when placed shall have a temperature of from 75 to 80 degrees.

Some sands are injured by too much heat. The same applies to certain varieties of pebbles and broken stone. A temperature not exceeding 150 degrees Fehrenheit will generally prove most satisfactory.

Place concrete immediately after mixing so that none of the heat will be lost before placing in the forms.

Warm metal forms and reinforcing before placing concrete. Be careful to remove ice and snow and frozen concrete remaining on forms from preceding work. Forms can be warmed by turning a jet of steam against them or by wetting with hot water.

Even though materials have been heated and the concrete placed immediately after mixing, it will lose much of its heat if not protected from low temperatures.

To protect the concrete immediately after placing. Canvas covering, sheating, housing-in the work, or hay or straw, properly applied will furnish the required protection for some work. In addition to these means, small oil or coke-burning stoves or salamanders may be used in enclosed structures.

Temperatures which may not be low enough to freeze the concrete may, nevertheless, delay its hardening for a considerable time. Do not expect concrete placed when the temperature is low and remains low for some time afterward to be safe for use as soon as though placed during warmer weather.

If concrete is unavoidably delayed or interrupted the work should be covered until concreting is again begun.

Cover and protect any section of the work as soon as completed. In severe cold weather, continue this protection for at least five days.

Forms must not be removed from the concrete work too early. This applies to any concrete work, regardless of season, but is particularly important with work done during cold weather.

Frozen concrete sometimes very closely resembles concrete that has thoroughly hardened. When frozen concrete is struck with a hammer, it will often ring like properly hardened concrete. Before removing forms, examine the work carefully to see whether it has hardened or is simply frozen. To determine this, remove one board from some section of a form, pour hot water on the concrete or turn the flame of a plumber's blow torch or a jet of steam under pressure against the concrete. If frozen, the heat will soften the concrete by thawing the water contained in it.

Road and Street Signs

The erection of handsome and durable signs, not only at the street corners, but far out on the roadways of the surrounding country, is coming to be fairly common among progressive American cities. In many places the municipal government is awake to the advantages thus secured, and in others the chamber of commerce or the automobile club has taken the marking of the streets and roads into its own hands as a matter of business enterprise and community betterment.

Out on the country roads, good, clear signs telling the direction and distance to important towns are as much appreciated by motorists as good road surfaces. "Keep to the right" signs at bridge and park entrances are often fully as effective as the services of a policeman.

The sign which was painted on a wooden board has been very useful in its day, but that day is past. People now demand something which is at once more attractive in appearance and capable of longer service. Sheet metal, protected by paint or by enamel, makes a very good sign for many purposes. Some of the enameled signs are quite handsome. They have the disadvantage, however, of not being able to withstand accidents or abuse. To meet such conditions, a sign of heavier metal and of very durable construction is demanded. One type is made from comparatively heavy plates of pure iron in which depressed letters are formed by a milling machine. A border is pressed around the edge of the plate, adding decidedly to appearance and rigidity. After the sign is galvanized, the letters are filled with a white compound. Then the remainder

face, recoating the body of the sign, but leaving the depressed letters untouched. This can easily be done without removing the sign from the post.

The relative visibility of different combinations of color, as between letters and background, has been made the subject of some interesting studies in connection with the science of optics. It seems now to be decided that white letters on a black background are readable at a greater distance than any

BLACK AND WHITE SIGN FORMED BY MILLING LETTERS ON ARMCO IRON PLATE AND FILLING WITH WHITE COMPOUND.

of the sign is covered with black paint or enamel. If the sign becomes soiled or defaced by years of exposure, its appearance can readily be restored by passing a point roller over the sur- other combination. Unless the weather conditions are such as to produce unusual darkness, well-formed white letters on a black background are easily readable at short distances at any time of night.

Cast iron signs are very durable, but are not adapted for all locations on account of the difficulty in maintaining a fresh and attractive appearance. There are, nevertheless, locations where they give very good service.

Cities Should Continue Planning Improvements During the War

By Alexander Potter, Consulting Engineer, 50 Church St., New York City

(The editor's influence has been steadily exerted in favor of continuing the construction of public improvements during the war. In our opinion the suspension of a great industry, like the construction industry, for the period of the war will not only be very bad for business generally, but will weaken the national morale and this will be quickly sensed by our enemies. This will prolong the war. But since there are bound to be some postponements of construction in response to the suggestion of the Secretary of War, and because of other considerations, this argument, by Mr. Potter, urging cities to go on planning improvements, is timely.—Editor.)

The Federal Government, through the Secretary of War, has recently requested municipal authorities to abandon public improvements during the period of the war, excepting such improvements as are absolutely necessary for the well-being of the municipalities or essential in the conduct of the war.

There is undoubtedly some construction work under way or contemplated which can be deferred until the end of the war without causing any serious inconvenience or affecting the health and well-being of the community. While the request of the government will unquestionably play havoc with certain contemplated plans, it is proper to inquire how municipalities can use to the best advantage this enforced inaction so far as construction work is concerned.

Cities Should Not Postpone Planning Public Works

In the request of the Federal Government there is not even an intimation that cities should postpone the proper investigation of contemplated improvements. Throughout the United States and Canada the period between the authorization of a project and its construction is in many cases entirely inadequate for the study and preparation of proper plans, and as a consequence glaring errors and mistakes have at times crept into public works which could have been avoided by a more thorough, painstaking and exhaustive examination of all conditions. It is unfortunately true that in too many instances it would seem that the point uppermost in the minds of many of the officials of municipalities is to get work on some plan started. The economic aspect of the project, the possibilities of so designing it as to make it adaptable for future expansion, and the proper, thorough and painstaking examination of various alternate plans which might be adopted are features which are given very much less consideration than they deserve. If, therefore, there can be brought home to the minds of officials the importance of using this period of enforced inaction, so far as construction is concerned, for a more careful working out of the details of projected plans it will be time well spent and will in the end tend to the betterment of public works. Too much time cannot be spent or too much study given to the development of well-considered and comprehensive plans, nor can the giving of sufficient time for the criticism of such plans by all who may be interested in their construction, be they taxpayers or city officials, result in the long run in anything but good.

Gain in Time Will Make Cities More Independent of Regulating Commissions

This situation, viewed from another standpoint, provides an excellent opportunity for the curtailment and eventual elimination of an evil that has assumed vast proportions and is destined, unless curbed, to assume still greater proportions. Throughout the country state and federal commissions of various sorts have been legislated into existence, clothed with arbitrary powers, in connection with all classes of public works. It would be absurd to deny that in many cases much good has resulted from the creation of these commissions. The work of these commissions overlap so that plans for a simple water works or sewerage system in some cities cannot be proceeded with until the plans, or certain phases of them, are approved by as many as four different commissions. If the appointees to these positions of trust and responsibility are not only honorable men, but men gifted with a sense of proportion, the evils which have arisen would not overbalance the good which they accomplish. It is not a difficult matter to select honorable men for these positions; it is, however, an exceedingly difficult task to secure an honorable man gifted with a proper sense of proportion. As a result of the selection of improper men many of these commissions are assuming arbitrary and unwarranted functions.

Under normal conditions these assumed powers, however arbitrarily applied, are allowed to pass without question, because, in the construction of public works, the effort put forth for the crystalization of the project and for the securing of the people's authorization have left the average official in such a state of mind that when the plans are finally submitted to one or more of the various state commissions whose approval is necessary before the actual work can proceed, he is willing

to accept any condition which these commissions may impose rather than risk any further delay. The possibility of injunction proceedings from one of a number of sources is often an added cause for acquiescence in intolerable and unjust conditions imposed by state and federal commissions. Therefore, the enforced delay in the execution of public works affords a most excellent opportunity for cities having schemes to put through to consummate the plans for such schemes and submit them to these various commissions. As there will be no particular advantage in securing the immediate assent of these commissions, officials of municipalities will be in a position to stand upon what they conceive to be their rights and oppose with all their vigor any unjust or unnecessary provisions or requirements which such commissions seek to impose upon municipalities. If the membership of these commissions and their employees are honorable men and have that sense of proportion with which they should be endowed, they will not seek to destroy, but will collaborate with cities in any just criticism of arbitrary action on the part of the commissions.

Cities Should Plan Now on Comprehensive Basis

In view of these conditions, it is to be hoped that municipal officers will not take the dictum of the Secretary of War as meaning that cities should shelve all consideration of these public improvements, but, on the contrary, cities should not only take advantage of the time at their disposal to develop to their full maturity plans for constructions that they have in contemplation, but should also look into the future and see what other plans for the welfare of the city might be suggested and developed in this time of waiting.

Among the public improvements that cannot be decided offhand, but which require long and careful consideration, might be mentioned the following:

(a) New or improved water supply;
(b) Purification of water supply;
(c) Systematic extensions of sewerage systems;
(d) Elimination of nuisances caused by the discharge of crude sewage into bodies of water too small to absorb the sewage;
(e) Street widening;
(f) Creation of public parks;
(g) Garbage disposal;
(h) Permanent pavements;
(i) City planning.

After the war is over there will be, at first at least, many idle men, and plans for the utilization of their labor along effective channels will prove to be of the highest value to the public welfare. With the cost of the war to meet, there will undoubtedly be a tendency to think that we must retrench in public improvements, whereas, after the war, the development of these public improvements will be the wisest, safest and best thing that the country can do to utilize labor and preserve the economic balance. In the meantime the force of engineers and men employed in the development of plans for these projects is relatively small, making few inroads upon the men needed for strictly war purposes.

If this conception is properly developed, it should result in great good for the country.

PAVEMENT DESIGN AND CONSTRUCTION

Combining Road Materials to Withstand Forces Incident to Motor Haulage

So severe has been the tax upon leading country roads that new expressions or terms have come into use, for example, sometimes it is said that a road has "failed" or has been "destroyed." In former years stone roads were described as "worn out," and, speaking generally, the statement signified prolonged service. The word "destruction" as applied to early roads, usually meant the ruin occasioned by torrential downpours, rapidly melting snows, or the overflowing of gutters and streams during protracted storms.

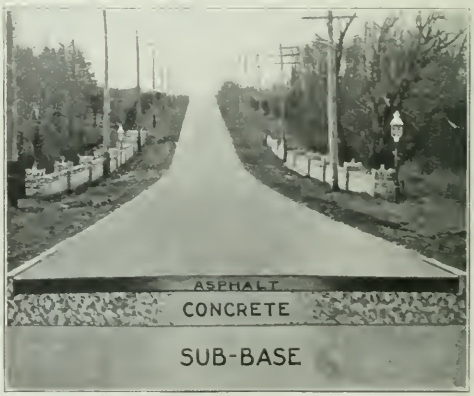
Some New Road Terms

It is a curious fact that in the destruction of stone roads today motor traffic operates along nature's lines, the difference relating to agencies rather than results. Where fast-flowing water washed away the road dust or binding material of stone roads, the rapidly revolving wheels of the motor car suck it up and disperse it in clouds of dust. Just as torrents loosened and displaced the stone, the motor car separates and scatters it.

Motor-propelled vehicles operating at high speed impose great stresses in the hard surface of a road. When this form of traffic consists in part of the transportation of heavy loads by motor trucks running on solid tires, it means severe strain upon road foundations.

Thus, when comparatively new and well-built stone roads succumb to traffic within a very brief period of time, as many of them do, it cannot be said, strictly speaking, that they have "worn out." Foundations have been crushed and wearing surfaces torn asunder; hence the terms "failed" and "destroyed."

To meet successfully the destructive forces described, whether imposed by traffic or the elements, engineers are putting down on heavy-traffic country roads a combination of materials peculiarly adapted to the purpose.



ILLUSTRATING COMBINATION OF ROAD MAKING MATERIALS TO WITHSTAND HEAVY HAULAGE.

Combined Concrete Base and Curb

Beginning with the road-bed or sub-base, they seek to bridge it with a material capable of sustaining great weight. While broken stone may be made sufficiently thick and compact to carry weight, a cheaper and more certain method consists of

spanning the sub-base with Portland cement concrete. The advantages of a road base of this type are many. The more important are as follows:

A concrete base is stronger than a stone base of like thickness. Cast in the form of a solid slab, concrete will bridge the sub-base. Thus any depression in the latter are spanned, whereas broken stone would be likely to settle at such points. In the case of a concrete slab, stresses are distributed instead of being confined to a small area. The thickness of a concrete base may vary in conformance with varying traffic requirements. A concrete base constitutes the greater part of the road—in many cases three-quarters of its thickness—which means that that much of the road is permanently established and should never require repairs or renewal if properly protected.

In putting down a concrete base it is an easy matter to cast integrally with the base substantial concrete curbs, which will prevent the wearing surface from breaking or spreading at the sides.

No highly technical processes or knowledge are required to construct a concrete base successfully. Any capable contractor can lay a concrete base.

When the wearing surface finally succumbs to traffic, it can be renewed without disturbing the base, which means virtually a new road at about half the cost of the original road, or perhaps less, the difference depending largely upon the cost of grading for the original road.

Thus engineers have solved the problems growing out of the destruction of roads by extreme weight of traffic. From every point of view a concrete base is a permanent and satisfactory investment.

Asphaltic Wearing Surface

The final step in the construction of the road is laying the wearing surface. Practical test under severe traffic conditions has demonstrated the utility and economy of the various types of asphaltic surfaces, when a thoroughly seasoned natural asphalt is used.

Asphalt is extremely tenacious, but not hard and brittle. Perhaps the best way to make this clear is to say that it is elastic under traffic as distinguished from a surface likely to spall or fracture. When a small irregularity in a newly-constructed asphalt surface disappears it is commonly described as having "ironed out" under traffic, which only a slightly plastic material would do.

Asphaltic surfaces are never transformed into dust or mud, and the stone in the wearing surface is not thrust aside or dispersed when bound with asphalt.

The slightly yielding or resilient property of asphalt provides a cushioning effect which prevents the road surface from crushing and powdering under the solid tires of the heavy motor truck.

Asphalt surfaces present an even and unbroken expanse upon which motor cars can run at high speed without jolting or damaging vibration. They are repaired with the same material used in original construction, hence the absence of disfiguring patches or streaks of contrasting color. An impervious asphalt surface protects the concrete base from extreme changes in temperature and moisture conditions, thus preventing destructive expansion and contraction.

Advantages of Combined Concrete and Asphalt Roads.

The theory that has led highway engineers to resort to asphalt and concrete for country roads can be explained in less than a dozen words: Concrete prevents roads from breaking down, and asphalt resists traffic wear.

With motor-truck traffic increasing at a pace totally unforseen a few years ago, and with still greater increase in the volume of automobile traffic, important inter-city and interstate thoroughfares will be subjected to tests far more severe than anything encountered in the past, and the traffic a road is likely to carry will doubtless govern engineering decision as to the type of asphaltic surface to be applied. In some states engineers have resorted to sheet asphalt, such as is found on heavy traffic city streets. This has been adopted upon the conviction that ultimate economy will soon compensate for slightly higher initial cost. Next in point of durability comes asphaltic concrete, a little cheaper than sheet asphalt and not quite as dense. It is in this connection that the economy of the type of road described is emphasized. Should asphaltic concrete be adopted in the first instance and renewal be required after years of traffic, there could be substituted for it, should increased traffic warrant it, the higher class sheet asphalt, as the concrete base would be adapted to either type of sufrace.

Experience of Various Cities with Street Curbing Materials

The following information has been collected at first hand from officials of engineering departments in various American cities. The matter presented gives a good idea of the experience of cities, in the Middle West especially, with curbing materials.

Champaign, Ills. Fred C. Lohmann, City Engineer, uses concrete combined curb and gutter exclusively. The experience with this type of construction in Champaign has been favorable.

Chicago, Ills. Julius G. Gabelman, Chief Street Engineer of Chicago, reports that this city has natural sand stone curbing on a great number of streets although there is no precise record of the mileage in service. Very little maintenance is required on this curbing, though there is a small percentage of breakage at the joints. Chicago climatic conditions are rather extreme, ranging from 100 degrees in the summer down to about 30 degrees below zero in winter. Sand

STREET SCENE IN LORAIN, OHIO, WHERE OVER 50 MILES OF NATURAL SANDSTONE CURBING ARE IN SERVICE.

stone curbing has successfully withstood this climatic test. He reports that this type of curbing is easily repaired because a broken curb can be easily replaced or redressed. In connection with street widening and repaving, quantities of this curbing have been successfully taken up and relaid. Several types of sand stone curb are in service in Chicago on various streets and were placed at various dates and all have given good satisfaction. Mr. Gabelman considers that this type of curbing is unusually resistant to effects of the weather. A very small percentage of this curbing is cracked or chipped as a result of natural forces.

Elgin, Ills. The prevailing practice in Elgin, as reported by M. H. Brightman, City Engineer, is to use concrete curbing. There is some sand stone curbing in the city that was placed prior to 15 years ago and this has given good service.

Evanston, Ills. The city of Evanston has in use about 400,000 linear feet of Berea sand stone curbing 4 ins. thick, and from 27 to 36 ins. in depth. I. C. Brower, commissioner of Public Works, reports that this curbing is all in good condition except for natural wear and tear and slight settlement in some places. Some maintenance and repair cost is necessary in connection with this curbing due to breakage by traffic teams and to settlement, expansion and contraction of pavements. Mr. Brower finds that this material is easily repaired and maintained because the material does not deteriorate and can easily be re-surfaced and relaid. He considers that the best curbing installation he ever put in was that on Colfax St. which was laid in 1916. This curb is a natural sand stone on concrete footings instead of lime stone curbing.

Moline, Ill. Lyle Payton, City Engineer of Moline, reports that they have considerable natural sand stone curbing installed in that city. On 12th Street, .83 miles was laid at a cost of $2,900.00 per mile, and 1.71 miles at the same price was laid on 4th. Ave. At a cost of $2,640.00 per mile, 1.62 miles was laid on 4th Ave., and 1.25 miles on 10th Street. Some maintenance and repair cost is required on this curbing, which is in good condition, owing to the heaving of frost which shoves and raises the curbing sometimes and in some places. There is also an abrasion on the curb by vehicles turning corners. Mr. Payton states the curbing he laid in 1910 on 16th St. between 11th and 19th Ave., of Kettle River sandstone, is the best curbing installation he has made. A negligible amount of curb cracks or chips and the same can be said about the amount of repairs or renewals that are necessary.

Indianapolis, Ind. B. J. T. Jeup, City Engineer, reports that about 25 years ago some 4x18 in. Berea sand stone was used in Indianapolis. This curbing was replaced by 5x24 in. stratified lime stone. The old curbing was in good condition when replaced and showed no signs of deterioration. The new pavement required a deeper curb and this was the only reason for removing the sand stone curbing. Mr. Jeup expresses a favorable opinion of the ability of this curbing to withstand climatic conditions.

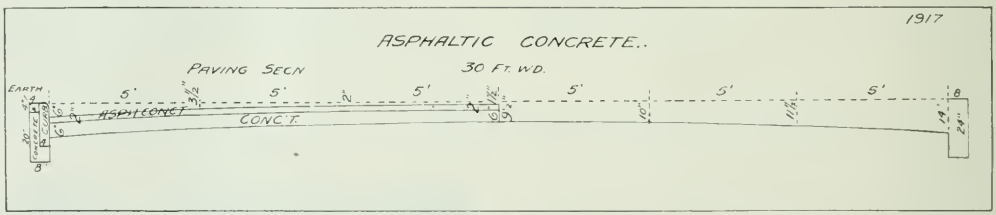
Terre Haute, Ind. Frank A. Kattman, City Engineer, reports that on radius curb corners granite curbing is used and in all other places concrete curbing or sawed lime stone is employed.

Davenport, Iowa. Roscoe E. Sawistowsky, City Engineer, reports the use of natural sand stone curbing on about 50 streets and aggregating 50 miles in all. This curbing is all in good condition. There has been some settlement of the curbing due to excavations in the street and this has necessitated a minor amount of maintenance cost. In Davenport the experience has been that sand stone curbing is easily repaired and satisfactorily maintained because of the ease with which it can be reset and retrimmed. There has been no cracking or chipping as a result of natural forces. Some repairs and renewals have been necessary at corners where heavy wear occurs.

Bay City, Mich. H. C. Thompson, City Engineer, reports that Bay City used Medina curbing up to about 10 years ago and since have been using concrete. The curb above the gutter is 6 ins. wide at the top, and 7 ins. wide at the junction with the gutter and is 18 ins. deep.

Detroit, Mich. On residence streets and streets with light traffic in Detroit, W. J. Wallace, paving engineer, reports that Amherst and Berea are used and with the exception of an occasional chipping due to an inferior piece of stone, these types of curbs are giving very good satisfaction. On business streets and streets with heavy traffic, Medina sandstone is used exclusively. On all streets, regardless of the type of curbing used, the circles are of Medina. The only instances in which Detroit has used concrete curbing in the past few years are where on account of transportation difficulties the contractor has been unable to furnish the stone curbing. There is shown herewith a cross section of a Detroit street showing a stone curb. Where concrete is used the size is 6x24 ins.

Grand Rapids, Mich. C. A. Paige, Asst. Engineer of the Department of Public Service, reports that the prevailing practice in this city is to use concrete curbing either straight or combined curb and gutter. There is quite a bit of sand stone curb in the city which was installed prior to 10 years ago and the department has occasion at times to reset it in the repaving of some streets. Mr. Paige considers it good curbing and says their use of concrete curbing is based entirely upon local cost consideration.



CROSS-SECTION OF A DETROIT STREET WITH NATURAL SANDSTONE CURB.

Kalamazoo, Mich. The city of Kalamazoo has used a variety of curbing materials as reported by A. Lenderink, City Engineer. These types comprise Berea stone, Medina stone, Bedford Lime stone, concrete curb and gutter and Laurel stone. Mr. Lenderink reports satisfaction with the use of sand stone curbing as he finds very few stones broken and these can easily be relined. At corners of course some repairs have been necessary.

Duluth, Minn. L. Ayres, City Engineer, reports extensive use of sand stone curbing in his city. Duluth has several miles of Berea laid about 1890 and still in good condition. The city is now using Kettle River sandstone for curbing.

Omaha, Neb. John A. Bruce, City Engineer, reports extensive use of Colorado stand stone for curbing. This stone is of a reddish color. He states that it has given excellent satisfaction. In a number of cases he has repaved streets curbed with this material and in very few cases has any new curb been necessary. All that has been necessary has been the readjustment of the old curb to the new line of grade. He estimates roughly that there are 100 miles of streets curbed with this material.

Buffalo, N. Y. Geo. H. Norton, City Engineer, reports extensive use of Medina sand stone. There has also been some Berea curbing laid, notably in the summer of 1916, when it was laid on two streets.

Columbus, Ohio. Practically all the curbing in Columbus is natural stand stone. The Columbus specifications are open

but nearly every street that is curbed is curbed with sand stone. This is the report of Henry Maetzel, City Engineer. He reports Columbus has taken up and relaid some of this curbing when streets were being repaved. He is a most enthusiastic champion of natural sand stone curbing and reports entire satisfaction with its use.

Lakewood, Ohio. Lakewood has about 70 miles of paved streets on which natural sand stone curbing is laid and it is all in good condition. The average cost of this curbing is $2,640.00 per mile, or 50c per lineal ft. C. A. Fisher says that this curb is easily redressed, reset and additional pieces are readily set in. The best sand stone curbing installation that he has put in is that on Lewis Drive made in 1916. There have been no failures from weather conditions.

Loraine, Ohio. C. M. Osborn, City Engineer, states that Loraine has over 50 miles of sand stone curbing. Some of this curbing has been in place for 20 years and is in good condition. In 1914 the cost was 47c per lineal ft. and in 1917, 60c per lineal ft. in place, including a bed of cinders. He reports complete satisfaction with the use of this material.

Mansfield, Ohio. W. J. Hazeltine, City Engineer, reports ¾ of a mile of Berea curbing on Wayne St., 3/5 of a mile on West 4th St., and 1.8 of a mile on East 5th St. All this is in excellent condition. Mr. Hazeltine states that the best sand stone curbing installation he ever put in was with Berea on South Main St., in 1896.

Marietta, Ohio. E. Frank Gates, City Engineer of Marietta, states that from 1892 to 1911 his city laid 22.6 miles of 5x18 in. Berea curbing at prices running from 32c to 45c per ft. It is all in use at this time and in excellent condition with no renewals for damage caused by natural causes and very few from any other causes.

Marion, Ohio. W. S. Ault, City Engineer, states that Marion has 40 miles of street paving and that on this paving 98% of the curbing is Berea sand stone measuring 5x18 ins. He finds the curbing easily repaired and maintained.

Youngstown, Ohio. F. M. Lillie, City Engineer, reports the exclusive use of natural sand stone curbing. They are mostly a local sand stone because of the cost consideration. He says that all sand stone curbing is good.

Zanesville, Ohio. C. R. Spencer, City Engineer, states that there has been nothing but concrete laid in his city for the last 10 years. Prior to that time a good deal of sand stone curbing was laid and this has proved satisfactory.

Pittsburg, Pa. N. S. Sprague, Chief Engineer, advises that until about 5 years ago all curbing installed was sand stone but since then protected (steel angle bar) concrete curb has been used exclusively. He reports satisfactory use of the sand stone curbing and calls attention to exceptionally good installations made in 1911 and 12, in the North Side flood district of several streets bounded by Federal St. to Goodrich St. River Ave. to Lacock St.

Memphis, Tenn. D. C. Miller, City Engineer, reports granite curb is easily obtained in Memphis and lasts indefinitely and so it is used almost exclusively although there is a very small amount of sand stone curbing in that city.

Outstanding Features of Road Work in Utah in 1917

By Ira R. Browning, Engineer, State Road Commission of Utah, Salt Lake City, Utah

The outstanding features of road work in Utah during the current year include the maintenance of 2,000 miles of established state roads, the grading of approximately 400 miles of highway, the paving of 10 miles and surfacing of approximately 100 miles.

The maintenance has been unusually difficult this season, due to the prolonged period of storm during the spring and followed by an unusual drouth. This has resulted in the breaking of the thin shale or clay surfaces on earth foundations and has rendered some of the newly graded roads nearly impassable. Repairing with the usual methods, equipment and materials has not proved adequate to sustain the heavy traffic on the surfaces that have become so badly disintegrated during the drouth.

The extension of the work of grading roads into the rural districts has brought large producing areas within reach of the markets for the first time in their history. Many roads that were formerly unfit for automobile traffic are being made into passable highways for motor vehicles.

For the year 1918 the program includes about 400 miles of roads to be improved under the Federal Aid Road Act, the paving of about 10 miles of important highway, the repairing or replacement of numerous highway bridges or culverts, and the establishment of road patrols for maintenance of all roads that sustain heavy traffic.

Some Features of Road Work in Kentucky

By Rodman Wiley, Kentucky Commissioner of Public Roads, Frankfort, Ky.

The Kentucky Department of Public Roads has for the past two years been advocating a type of floor for bridges which we believe, and which has proven, to be most satisfactory and yet rather inexpensive. Creosoted nailers are bolted to the top flanges of the joists, being sized in such a manner as to give a 1-in. crown to the roadway; two by fours which have been sized are then placed thereon and spiked to the nailers as well as to each other, and all points of contact are coated with hot tar. We believe that such a floor will last from eight to ten years. It is, of course, practically waterproof and stiffens the structure considerably; in fact, a floor of the above type can be placed on an old structure and remove the rattle almost entirely. It certainly is a great deal more economical than the ordinary wooden floor and because of this stiffening effect to the structure prolongs the life of the bridge several years.

Also in one of the counties in this state we have made a great many experiments as to the best methods of building a road, using river gravel. Clay has been used as a binder in all the experiments. We have tried placing the gravel in two courses, with the binder between; in other words, the sandwich method. The road would then be thoroughly harrowed, dragged, etc., in order to thoroughly incorporate the clay with the gravel. We have also tried placing the gravel in one course, with all the clay binder on top, after which the usual harrowing and dragging method would be used. It has been found in both the above cases that a good road can be built, but that it requires several months for the gravel to set up.

We are now placing the gravel in one course, the clay binder on top and plowing the material with an ordinary plow, and it has been found that is the best method for incorporating the binder with the gravel. If necessary, a harrow is then used to smooth the surface. It is then dragged and sets up in a short time.

This state has no law which allows the state to participate in the cost of maintaining roads, but it is highly probable that such a law will be passed at the next legislature.

As regards the work in this state for the year 1918, I will say we expect to do a considerable amount of Federal Aid work, and from present indications the various counties in the state will do about the usual amount of road work.

Motor Truck Haulage on Freight Highways

In a few years there will be freight highways and trucks will be kept off the roads used by pleasure cars; these freight ways will be heavier than roads being built today, and they will need to be, said George A. Ricker, Highway Engineer of the Portland Cement Association in addressing the Oklahoma Engineering Society. He ventured this prediction a year ago and a few days later came news that a freight highway had just been opened between Los Angeles and San Pedro. This road is 40 ft. wide, with a sub-base of stone, and it is surfaced with an 8-in. concrete pavement.

On these freight roads of the near future heavily loaded trucks, probably with trailers, will be carrying a lot of freight that is going by rail now, and from important terminal points there will be lighter trucks delivering to the door of the consumer. One of the greatest economic questions today is the distribution of the products of the country, particularly the food supply, and the freight highway is going to solve that problem. How great a part the motor truck and improved roads will play in the transportation of food, munitions and even troops in the near future we can only surmise. Under the stimulus of war preparation these to us new and vital questions are being given serious consideration.

During this year of unusual business, under unusual conditions, there have been established regular motor truck operations between the larger cities of the East that have supplemented railroad freight service, which have proven entirely inadequate to the demands upon it.

Day and night communication over the highways have been maintained between the great manufacturing cities of Ohio and the seaboard. The transport of freight between Boston, New York and Philadelphia has been constant, and without this truck service business would have been more hampered than it was; we have it on good authority that "many a factory and business house in Cleveland would have shut down this summer, or have been run on part time, had it not been for the fleets of motor trucks that have poured over the roads from Akron, Elyria and other points."

Four Widely Separated, but Representative Concrete Highways

That concrete will figure prominently in the construction of freight highways is assured. Interest attaches to existing concrete roads and four representative ones are here illustrated.

The Axtell Road is in McLennan County, Texas, near Waco. It was built in 1915 and the photograph shown was taken in October, 1916. The road is 1,700 ft. long and 15 ft. wide. It is of 1:2:3½ concrete and is 4½ in. thick at the side and 6 in. at the crown. It is not reinforced. Joints are armored and are 30 ft. apart. This road was built by J. W. Bernard, Waco, contractor, and R. J. Windrow of the same city was engineer.

VIEWS OF FOUR WIDELY SEPARATED BUT REPRESENTATIVE CONCRETE ROADS. READING FROM LEFT TO RIGHT: AXTELL ROAD, McLENNAN CO., TEXAS; FOSTER ROAD, MULTONOMAH CO., OREGON; PERU CENTER ROAD, HURON CO., OHIO; HOLLY-BROCKPORT ROAD, ORLEANS CO., NEW YORK.

The Foster Road is in Multonomah County, Oregon, near the city of Portland. It was built in 1915. It is 21,571 ft. long and 18 ft. wide. It is of 1:1½:3 mix and was laid in one course. Joints are armored and 30 ft. apart. This road cost $1.25 per square yard and was built by the Montague O'Reilly Company of Portland, Ore., and was designed under the direction of State Highway Engineer Herbert Nunn.

The Peru Center Road is in Huron County, Ohio, near the city of Norwalk. It was built in 1915 and the photograph was taken October 15, 1916. The view features the satisfactory use of concrete on a grade. This road is 3,800 ft. long and is 10 ft. wide. The view shows the advantage in constructing a 10-ft. roadway on one side of the center line of the road so that an additional width may be placed when the traffic war-

rants it. This road is of 1:1½:3 mix and was laid in one course. It is 5½ in. thick at the side and 6¾ in. at the center. Joints are 50 ft. apart. The road is not reinforced and was laid on a clay foundation. It was built by Contractor Riley Pardo, of Norwalk, according to plans prepared under direction of L. C. Herrick. It cost $1.13 per square yard.

The Holly-Brockport Road is in Orleans County, New York. It was built in 1914-15 and the photograph was taken July 5, 1917. It is 2.4 miles long and 16 ft. wide. It was built by Contractor W. C. Rich, of Youngstown, N. Y., under the supervision of Perry Filkin, Division Engineer of the New York State Highway Commission, Rochester, N. Y.

PAVEMENT CLEANING AND MAINTENANCE

Method and Cost of Using Compressed Air Equipment in Making Street Openings

By H. L. Hicks, New York, N. Y.

The labor problem in municipal work, as in other fields of construction and maintenance, is calling for increased effort to replace men, who cannot be had, with machinery. For certain phases of the work pneumatic drills and kindred tools have proven their worth. Such drills as the Jackhamer, a 40-lb. self-rotating hand hammer drill, have taken almost entire possession of the field of rock removal in municipal contracting. It is but natural that, as contractors came to appreciate the handiness of a tool, they should begin to think of jobs, other than rock drilling, that could be done to better advantage by its use.

The removal of asphalt, concrete or block paving in opening streets for the laying of water, gas or sewer piping, electric conduits, etc., has been, by hand work, a relatively expensive job. By applying air tools the cost has been lessened, the work speeded up and better results obtained.

Removing Concrete Paving

In Des Moines, Iowa, electric service lines were to be laid in underground conduit. By hand methods it had been necessary to remove whole panels of concrete paving, in spite of the fact that a narrow trench was all that was needed.

The engineer introduced the Jackhamer and it was demonstrated that by using the air drill it was possible to restrict the cutting to a strip about a foot in width; a decided saving in the amount of pavement torn up. Hand work would have cost about 40 cts. per foot. With the introduction of two drills and an electric portable compressor it was estimated that the figure could be cut to 30 cts., but actual results showed a cost of 18 cts. per foot.

Removing Concrete Without Blasting

In cutting concrete, under such conditions as in the subway construction in New York City (Fig. 1), where the problem has been merely to tear out paving, foundations and other concrete without blasting, it is common practice to use a pointed chisel rather than the usual rock drill bit. As the rotation of the steel is unnecessary, shanks are made round instead of hexagonal. This, of course, renders the automatic steel rotating action of the drill inoperative. The chisel bit is very effective where concrete is of 3 or 4-in. thickness, as it permits the wedging and breaking off of relatively large chunks.

The problem of concrete pavement cutting has led to the adaptation of other air tools to the work. On part of the subway work, above mentioned, a heavy riveting hammer, when fitted with suitable chisel (Fig. 2), was found an excellent pneumatic pick. In other cases the pneumatic tie tamper has been fitted with a sharpened pick and developed (Fig. 7) into a conveniently handled concrete remover. In removing concrete pavement preparatory to replacing the rails of a Chicago street railway a strip 6 to 8 in. wide was torn out at a rate of 30 ft. per man per hour. Average performance reports indicate that pneumatic equipment will better the working speed of a gang of twice as many men using hand picks.

Removing Asphalt Paving

Somewhat akin to concrete removal is the taking up of

VIEWS ILLUSTRATING USE OF COMPRESSED AIR DRIVEN TOOLS ON STREET WORK. FIG. 1—BREAKING CONCRETE WITH JACKHAMER AND POINTED CHISEL BIT. FIG. 2—TEARING UP CONCRETE PAVING WITH PNEUMATIC RIVETER AND CHISEL. FIG. 3—CUTTING ASPHALT PAVING. FIG. 4—SCORING ASPHALT PAVING.

asphalt paving. For this service the tie tamper is a time and labor saver. A flat chisel of about 3 in. width is used. First the pavement is scored with the tool used as shown in Fig. 4. Then it is held upright as in Fig. 3 and the paving cut through and pried up. This method of applying tie tampers was developed by the street railways and shows such excellent saving that it will be undoubtedly applied by municipal contractors to similar work. At Elmira, N. Y., four men removed approximately 600 sq. ft. per hour, at a fraction of the cost of hand work.

Another tool also used for the same work is a smaller hand pick (Fig. 6). With this tool narrow grooves are cut, marking the portion of the asphalt to be removed, at an average rate of 20 lin. ft. per hour.

Removing Bitulithic Paving

Bitulithic pavement, being softer and of somewhat sticky nature, is removed in a slightly different manner. A chisel some 1½ or 2 in. in width is employed to make a series of cuts, each the width of the chisel and spaced about 2 in. apart.

Maintenance of State Trunk Highway System in Wisconsin

By A. R. Hirst, State Highway Engineer, Madison, Wis.

The Wisconsin Highway Commission has had in progress three experiments, one of which is along lines leading away from the beaten path. We have in this state many miles of sandy road far removed from ordinary construction and maintenance material. It has been the local practice to improve these roads by spreading hay, straw or other fibrous materials on the sand. This has given a very satisfactory road, but the effect is marked for only a short time as travel swiftly cuts the hay, etc., to pieces. We have been trying to improve on this practice by the addition of tar and sand with which we hope to form a tough, fibrous mat to carry travel. While our experimental roads have not been installed a sufficient length of time to warrant conclusions, their early showing is such as to cause us to have hopes that a cheap and efficient means of carrying travel over these sand roads may be perfected.

VIEWS ILLUSTRATING COMPRESSED AIR DRIVEN TOOLS ON STREET WORK. FIG. 5—REMOVING AND TOOTHING OUT BLOCK PAVING. FIG. 6—CUTTING ASPHALT WITH PNEUMATIC PAVEMENT PICKS. FIG. 7—ANOTHER CONCRETE CUTTING TOOL, THE PNEUMATIC TIE TAMPER, AT WORK.

Cuts of just sufficient depth to mark a distinct cleavage line are made on one side and the ends; the pavement is cut through on the remaining side, a crowbar is slipped under and the block or slab of pavement pried out. At Portland, Oregon, pavement of this kind was removed in slabs 4-ft.x4½-ft. at a cost of 49 cts. per square yard.

Removing Block Pavement

In tearing up block pavement (Fig. 5) any of the tools can be used, although a hand hammer is most useful when it comes to toothing out the edges of the section removed or cleaning used blocks of the adhering binder. With the introduction of air hammers a marked reduction in the breakage of blocks is to be noted. In one city where air tools are used it was found that a five-man gang using two hammers removed and cleaned 2,000 paving bricks in an 8-hour day—as compared with 1,000 brick for 10 men working by hand.

Entirely aside from the benefits derived from reduced cost of working is the improvement in public relations resultant from the shortened elapsed time during which streets are closed to traffic.

The Legislature of 1917, in the law assenting to the provisions of the Federal Aid Road Law provided that the State Highway Commission should select a State Trunk Highway System of not more than 5,000 miles or interconnecting all county seats and cities with a population of 5,000 or more. It provided that after May 1, 1918, this Trunk Highway System shall be maintained by the counties under the supervision of the State Highway Commission. The law provides further that the State's share of the cost of Federal Aid construction, and the cost of the maintenance of the Trunk System shall be financed from the proceeds of motor vehicle license fees.

The State Trunk System has been selected and the Commission is now making plans for next year's construction and maintenance program. It is expected that the Federal Aid construction program will amount to about $2,000,000 of which the Federal Government, the State and the Counties will each contribute one-third. As nearly as can be estimated, there will be available from the proceeds of automobile licenses for the maintenance of the Trunk Line System, about $175 per mile in 1918. The construction program contemplates Federal Aid work in approximately 50 counties. In selecting the

projects, the Commission has endeavored to locate the improvements on bad spots in important roads where there is little prospect of securing the improvement through local effort. The construction will not vary from state aid construction of the same type.

The outstanding feature of next year's work will be the maintenance of the Trunk System, and it is the intention of the Commission to make this work its first care. While there has been much high class road work done in this state, it has been badly scattered and there has been no systematic attention paid to the maintenance of the earth roads connecting the improved portions. It will be the aim next year to keep the entire 5,000-mile System in a good, passable condition all the time, and the energies of the Commission will be concentrated in an effort to build up a patrol system of maintenance which will attain this end.

The Best Method of Making Repairs to Pavements Torn Up For Water Works Construction

By John M. Diven, Superintendent of Water Works, Troy New York

With asphalt, bitulithic and other pavement on a concrete base, we have adopted the method in Troy of putting a concrete base in the excavation, after ramming the back-fill as hard as possible. Even though more soil is put back than is taken from an excavation it is, as we all know, very difficult to so fill a ditch that it will not settle any. To take care of this we use a very deep base, usually, on small excavations, much deeper than the original base. For service and small repair ditches the edges of the old concrete are cut with a bevel toward the opening, so that the new piece wedges in place, preventing the settlement even though there is some settling of the ground under the patch. This concrete patch is brought up to the level of the old foundation, or to the bottom of the finish coat and a piece of tar or other building paper laid on top of the new concrete, and a thin coat, the thickness of the surface finish of the pavement, of concrete put in. The paper prevents the thin finish coat adhering to the foundation course, so that it is easily broken up and removed when the regular repair gang comes along, said Mr. Diven in a discussion before the Central States Division of the American Water Works Association.

Patches of this kind often remain for a long time, frequently through a winter, and form a smooth efficient pavement surface. In at least one instance the repair gang have overlooked one such patch for several years. A little pains, and lamp black, will color the patch to fairly well match the old surface, so that it is hardly noticeable. If proper care is used the surface of the patch is absolutely even with the surrounding pavement and no jar is felt in driving over them.

We have used this method in Troy, N. Y., successfully on Hassam pavement, the only trouble being the greater difficulty in breaking out the surface course for final repairs, owing to its greater thickness. As there is no trouble in matching Hassam pavement in color the patches are frequently left, and some of them have stood heavy traffic for years. For these patches a rather fine gravel is used and mixed one to three with cement. No surface coat is used, simply tamping with an ordinary, square dirt tamper leaves a good surface.

The street flushers have made it impossible to continue the old method of filling with good sound gravel or other hard soil, keeping it surfaced till the ground is thoroughly settled and the pavement repair gang ready to put in permanent patches. The flushers gouge out such fills the first time over.

The above described method has not been used here over extension of mains, and, except in a much used street would probably prove too expensive; though it would undoubtedly be economical where a street improvement that was flushed nightly had been taken up to lay a water main. In some cases where the repair gang is due soon, the mixture is made poorer; just enough cement is used to hold the gravel in place against the force of the flusher stream for a few days.

WATER WORKS MAINTENANCE AND OPERATION

Methods Employed in Recovering a Pump From Bottom of Deep Well

By W. A. Judd, Water Commissioner, Mason City, Ia.

Well No. 9 at Mason City starts with a 19-in. hole which continues for 225 ft. At that point the diameter is reduced to 16 in. and at 540 ft. it is again reduced to 12 in. The well is 1,200 ft. deep. In this well is installed a 5-stage 17-in. American deep well turbine, motor driven. The turbine proper is at about 90 ft. below the well curb and below the turbine are two lengths of 9-in. suction pipe. Water normally stands in the well at about 85 ft. below the curb and pumps down about 7 ft. when yielding 1,200 gal. per minute.

The construction of this type of pump and its connections are well known. The weight of the pump is carried by the 10-in. flanged discharge pipe in 8-ft. lengths. Inside this discharge pipe is another pipe 4-in. outside diameter, held in position by spiders inserted in the flanges of the discharge pipe. This pipe is connected together by means of screw couplings, which also serve to hold the shaft bearings. Inside this pipe is the shaft.

Pump Overhauled Annually.

We make a practice of overhauling this pump once a year and were doing so on New Year's day of this year, said Mr. Judd in addressing the Iowa section of the American Water Works Association. The pump had been lowered together with four lengths of discharge pipe shaft casing and shafting. The fifth length of shafting had been screwed up tight and the fifth shaft casing was being set up solid when, without any warning, casing and shaft disappeared through the discharge pipe and with the pump and two lengths of discharge pipe went bubbling down to find a resting place on the ledge at 225 ft. below the surface. The two remaining lengths of discharge pipe were pulled out and it was found that in making up the shaft casing joint the discharge pipe had come loose from the flange.

Unsuccessful Effort to Couple to Shafting.

A well driller's advice was immediately sought, and he advised us to try to couple on to the shafting, which projects about a foot above the bearings. One of the shaft couplings was taken to a machine shop and the threads recut to make

a loose fit. One end was tapered out on the inside and the other end was cut down to a 2-in. pipe coupling. On the bottom was soldered a heavy funnel to center the coupling over the shaft. Two-in. pipe was then cut into about 10-ft. lengths for ease in handling and threaded. Because the shafting has a left-hand thread, it was necessary to drill each pipe coupling after the joint was made up and pin the pipe and coupling together. This was a tedious process, but finally the funnel was heard to strike the shaft. It was then raised and lowered a few times to be sure of centering and we started to twisting the pipe to the left. After several attempts it seemed to take hold and hoisting was attempted with an 8-ton chain hoist, which hangs from a trolley running on a 15-in. I-beam near the roof of the pump house. From the hard pull, we knew we had caught hold of the shaft, but at about the third pull on the chain, the coupling let loose and for a day we fished continuously without getting another nibble. The string of pipe was then pulled out and it was found that the funnel had bent over, allowing the shaft to center in the funnel, but to one side of the coupling. A heavier funnel was built, reinforced with steel ribs and bands, but even with this we had no luck, the shaft turning every time the threads engaged.

Special Fishing Tool Works Successfully.

During this time our day fireman had been telling of a fishing tool he had heard of, consisting of two rings. Just how the rings were operated no one knew until our blacksmith, who is a Britisher, said, "I gather you," and started to make the tool.

The small end of the funnel was cut off so the hole through it was about 5 in. in diameter. A fork was made to which the funnel was riveted. Above the fork was welded a piece of 2-in. shafting 3 ft. long in such a way that when the shaft and funnel stood vertical the face of the steel was about 2½ in. from the vertical line drawn through the center of the funnel. On the back side of this bar two ears were welded and punched for a 1-in. bolt. Two open rings were made, 5 in. in diameter, of ¾-in. square steel, with the ends bent back, flattened out and punched also for a 1-in. bolt. The top of the bar had a piece of 2-in. pipe welded to it, the rings were bolted to their places and wired together so they would move together on the bolts and a light wire was fastened to the top ring to hold them in horizontal position. The whole apparatus was then lowered into the well with the same 2-in. pipe, wire being paid out as the tool descended. The funnel centered the tool over the shaft casing all right, but when the rings were dropped by slacking the wire they did not bite into the casing enough to stand a pull, so the tool was again pulled out, a tool steel face put on the rings and then notched. A piece of flat tool steel was welded to the face of the vertical bar, and in it were cut some teeth, making it look like a wood rasp. The tool was again lowered and at 10:30 on the morning of the 7th of January caught hold of the shaft casing with a grip that scarcely anything could disengage. At the first pull it was evident that the pump was wedged tightly into the well, for instead of the pump rising the I-beam above was bending. Men were sent for props to put under the beam, but while they were gone the tension on the hoist suddenly slackened, showing that the pump was loose in the well, and pulling was started. At 10 o'clock that night, after pulling continuously, without stopping even to eat, the pump was landed on blocking on the well curb.

Experience with Leadite Joints at Windsor, Conn.

In drawing up proposals for the water mains contract at Windsor, Conn., alternative prices were asked; first, on laying cast iron pipes with cast lead joints; and, second, on laying cast iron pipes with leadite joints. The contractor to whom the work was awarded offered to do the work with leadite joints for 10 cts. per foot cheaper than with the lead joints. After favorable replies were received from several users of leadite, the officials determined to use that material. The experience gained in its use was reported by Superintendent Homer R. Turner:

Leadite was used on about 28,000 ft. of 10-in. water main. The material comes in the form of a black powder put up in 100-lb. bags. We used an ordinary portable furnace burning coke, controlling the temperature by dampening the fire with soil when necessary. One attendant is kept on this furnace continually, as the material requires constant stirring and proper control of the temperature to prevent burning. The leadite is melted until it is of the consistency of medium oil and the appearance of the surface of the liquid is smooth and free from bubbles. At this stage it has a mirror-like surface and is ready to pour. The temperature at this time is very slightly above the melting point and a higher temperature will cause bubbles to appear. Any increase in temperature will cause the material to thicken until it becomes stringy. If this occurs the pot should be removed from the fire and cooled until the temperature is reduced so that the material is of the proper consistency. Dry jute should be used in the joints. The presence of oil or grease from tarred jute prevents a good bond between the leadite and the cast iron pipe. The material is poured similar to lead. The leadite in the gate can be broken from the joint when cold and remelted after being properly cleaned. Experience proved that we have obtained better results with the joints if the pouring was kept back at least four lengths of pipe from the laying gang.

Use of Water Meters by Metropolitan Water District, Boston, Defers Construction New Works and Lowers Cost of Maintenance

The Metropolitan Water District of Massachusetts is at present made up of the following cities and towns: Arlington, Belmont, Boston, Chelsea, Everett, Lexington, Malden, Medford, Melrose, Milton, Nahant, Newton, Quincy, Revere, Somerville, Stoneham, Swampscott, Watertown and Winthrop. The Town of Swampscott was admitted under a special act of the Legislature, it being outside of the 10-mile limit prescribed in the act. The City of Newton, which is a part of the district, is still supplied from its own local source.

Previous to the formation of the Metropolitan Water District nearly all the cities and towns obtained their supplies from local and different sources and maintained separate pumping units, storage reservoirs and distribution systems. After the Metropolitan Works were put in service eleven sources of supply were abandoned and five pumping plants operated in place of twenty.

Introduction of Meterage.

In 1907 an act was passed that after January 1, 1908, all cities and towns which derived their source of supply from the Metropolitan Water Works should equip all new service pipes with water meters and should also equip annually with meters 5 per cent. of the services that were unmetered on December 31, 1907, and should thereafter charge each consumer in proportion to the amount of water used. The effects of meterage are here given as presented to the New England Water Works Association by Samuel Killam, Superintendent Pipe Lines and Reservoirs, Metropolitan Water Works.

The quantity of water consumed became a very important element and it was made incentive, not only for the district as a whole, but for each municipality, and finally, the most important of all, each consumer, to check and to stop the unnecessary and wasteful consumption of water.

The gradual installation of more service meters in the district has reduced the average daily consumption per inhabitant from 130 gals. in 1907 to 89 gals. in 1916.

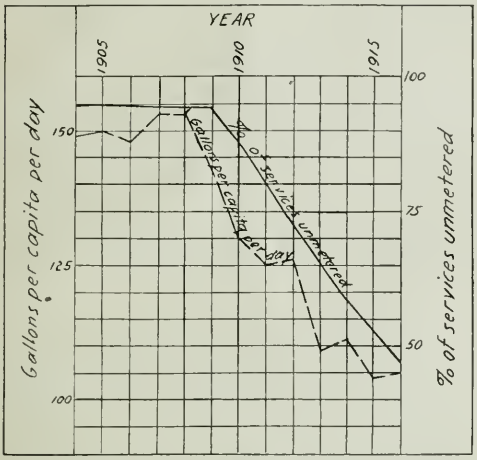


DIAGRAM SHOWING WATER CONSUMPTION PER CAPITA AND PERCENTAGE OF SERVICES UNMETERED IN THE CITY OF BOSTON.

The per cent. of services metered and the per capita consumption per day and at night in each city and town in the district for the years 1907 and 1916 were as given in Table I.

Table I—Per Cent. of Service Metered and Per Capita Consumption in Metropolitan Water District of Massachusetts.

	Per Cent of Services Metered.		Consumption Per Captia			
	Jan. 1,	Jan. 1,	1 a.m. to 4 a.m.		Av. Daily	
City and Town.	1907.	1916.	1907.	1916.	1907.	1916.
Arlington	33.6	100.0	50	28	91	59
Belmont	100.0	100.0	31	18	68	52
Boston	5.5	53.2	107	62	153	106
Chelsea	14.6	99.7	59	35	97	68
Everett	2.0	50.0	50	42	82	74
Lexington	2.1	92.0	43	37	69	69
Malden	93.6	95.5	22	28	46	49
Medford	10.5	100.0	65	22	102	46
Melrose	3.9	100.0	85	26	117	45
Milton	100.0	100.0	16	10	46	42
Nahant	17.2	64.1	50	51	130	110
Quincy	14.2	88.6	66	39	100	59
Revere	4.8	70.8	54	34	82	59
Somerville	24.6	69.2	55	34	90	69
Stoneham	1.9	98.5	55	29	91	58
Swampscott	37.8	100.0	41	28	85	59
Watertown	98.3	100.0	36	29	67	65
Winthrop	2.3	100.0	65	26	105	53
District	14.7	66.8	88	51	130	89

The effect of the use of service meters upon consumption of water is very graphically illustrated by the accompanying diagram showing the daily number of gallons used per capita in the City of Boston and the percentage of unmetered taps for each year, 1904 to 1916 inclusive.

Meters Defer Construction of New Supply Works.

If the conditions as they existed prior to 1904 had been allowed to continue additional sources of supply would, without doubt, have been required before the present time. It is also probable that if the act requiring the installation of service meters on all works receiving a supply from the Metropolitan Works had not been enacted it would have been necessary to construct additional works by 1920.

The estimated safe capacity of the Cochituate, Sudbury and Nashua River Works is 173,000,000 gals. per day.

It was estimated in the report of the Metropolitan Water and Sewerage Board to the Legislature of 1904 that the cost of new works required within the next 25 years to supply the probable demand for water, if the waste was not checked, to be at least $32,000,000, assuming that the district remained as constituted at that time.

The greater the quantity of water used the more it cost in the end to furnish water to the tap. At a fixed rate the consumer is charged a certain sum and naturally is not directly interested in leaky pipes as long as no damage is caused by the water. The leaks increase in volume and the quantity of water required for legitimate use is running to waste. Wasted water means larger mains, more pumping machinery, wasted coal and labor and finally extension of works for larger supplies and an increased sewer system to care for the wasted water.

Many are willing to pay for their own and their neighbor's waste by general taxation, but are unwilling to continue to pay for their own waste when presented with a quarterly bill.

The writer believes that water meters are as much a part of a well operated water works system as gas or electric meters are to their respective works. Many gas companies account for 80 per cent. of gas delivered through the master meters. Well managed water works in Europe account for all but 10 per cent. of their supply. Cannot American municipalities do as well?

Waste of water can be divided into two classes, leakage from mains and waste from service pipes. The first can be stopped by efficient management and the latter by enlisting the consumer's co-operation by giving him a direct pecuniary benefit. It appears to the writer that the best way to get results is to sell the water by measure and to keep the measuring devices in good working condition. The writer maintains that the waste which has been stopped in the Metropolitan Water District of Boston by the installation of service meters has deferred for the present the construction of additional works and reduced the cost of maintaining existing works.

Method Successfully Employed in Repairing Leaks in Belleville, Wis., Concrete Standpipe

Following are the suggestions made to the Township Board, by the waterproofing engineer, and carried out by the board in repairing the leaks in the concrete standpipe at Belleville, Wis.:

Specifications

Thoroughly clean down the walls on the interior with a solution of muriatic acid and water, 1 part of sand to 10 parts of water. Roughen the walls as much as possible with any sort of tool that is convenient. Where each joint occurs cut into the concrete about 1 inch.

Over the entire wall surface apply a plaster coat ½ to ¾ in. thick, well troweled and worked into the joint where the greatest seepage occurs. It will be necessary on the inside to carry this plaster up 30 ft. The last 20 ft. appears to be in good condition and not subject to any seepage. This is due to the lower water pressure.

Mix for plaster to be 1 of Medusa waterproofed cement and 1½ clean, sharp sand and sufficient water to be added to make a mortar that will stick well on the concrete wall.

Before applying this mortar to the old concrete see that the

walls are well saturated with water and a grout applied to them composed of plain cement and water washed over with a brush. On the exterior of the walls from the ground up 10 ft. thoroughly clean off all white substance and roughen up and wash down as previously specified—also cut in about 1 inch at the joints and apply a plaster coat as on the inside. This is to protect the work that has been injured by the frost. To improve the appearance of the water standpipe paint the entire exterior with a mixture of Medusa waterproofed white cement mixed with sufficient water to make a creamy paste.

On one side of this structure is to be seen what appears to be quite a fracture in the concrete. This does not run through the entire thickness of the wall. The loose part of this fracture is to be removed, thoroughly cleaned and plastered over with the mixture described.

Where any small cracks are shown to leak, cut a joint into them and fill with the mixture specified.

Results of Repairs

The foregoing specifications, suggested by H. C. Morrison, western representative and waterproofing engineer of the Sandusky Cement Company, were carried out in making the repairs. This structure is now in perfect condition.

Water Works Design and Construction

Method Employed in Constructing Ornamental Concrete Shell for Steel Water Tanks

The city of Cincinnati, having received complaints and opposition from real estate holders regarding the appearance of large steel water standpipes, has recently taken steps to improve conditions from an architectural standpoint, and ornamental concrete structures have been erected around the standpipes by the Ferro Concrete Construction Company.

EASTERN HILLS STANDPIPES, CINCINNATI WATER WORKS, ENCASED IN ORNAMENTAL CONCRETE SHELL.

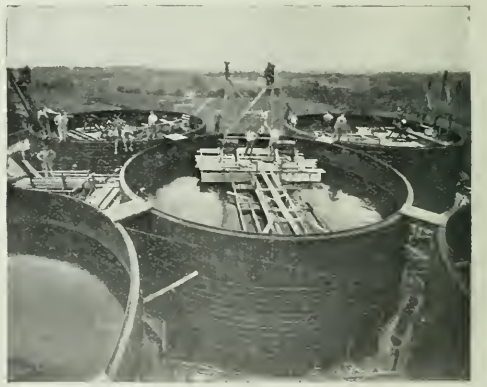
The accompanying illustrations show the Eastern Hills tanks almost completed. When finished, the top of the structure will present the appearance of the battlements of an old fort.

There are five tanks in the group on Eastern Hills and their relative positions will be seen from the illustrations.

Method of Erecting Forms

After the steel cylinders had been erected they were filled with water so that they would have the same shape as when in actual service. It was feared if concrete was poured while they were empty, slight changes in shape might take place when the water was let in, and this would cause cracking of the concrete shell.

The forms for the first section setting were supported on the foundation and braced to the ground. Forms for subsequent settings were raised from floats which can be seen in one of the illustrations. A lifting derrick will be seen at the extreme right of one of the illustrations. The derrick rests on a two-boom crab-operated rig resting on empty oil barrels on the water surface of each of the four corner tanks. Since each panel weighs about a ton, it is practically impossible to pick this weight from a floating platform of reasonable cost which would fit in a 40-ft. circle. Flotation is therefore used only when rotating the rig from one form to the next. In order to support the load the rear end of each float is blocked down from the Z-bar which forms the top of each tank, and the forward end is held by hooks over this Z-bar.



RAISING CONCRETE FORMS FROM FLOATS IN ENCASING CINCINNATI STANDPIPES.

No Interruption in Concreting

The foundation plan was about 100 ft. on the side and from 270 to 300 yds. of concrete is required for a complete lift, this to be distributed over a considerable area. It was therefore possible, by using stop planks, to concrete one-half of the structure while the horizontal reinforcing was being set and

while the forms were being raised on the other half; thus the mixing plant was kept going at the rate of 100 yds. or more a day. The total volume of concrete placed, exclusive of footings, was about 3,800 cu. yds.

The hoisting tower is double, one side being used for the concrete skip and the other having an elevator for the workmen. The tower also has a boom for raising the reinforcing.

Personnel

The tanks were designed and built under the direction of J. A. Hiller, general superintendent of the Cincinnati Water Works. T. J. Mulloy is resident engineer in charge. The Ferro Concrete Construction Company, of which W. P. Anderson is president, are the contractors. J. Hodges is in charge of the work for the contractors, while the forms and methods of construction were designed by Henry D. Loring, engineer for this firm.

Design and Construction of Water and Sewer Systems at Camp Custer, Battle Creek, Mich.

By Don W. Bingham, B. C. E., Assistant State Sanitary Engineer, Michigan State Board of Health

The National Army cantonment at Battle Creek, known as Camp Custer, is of the standard divisional type and will house the 85th Division of the National Army. The barracks are two-story type and contain kitchen and mess hall facilities. Toilet and shower bath accommodations are provided in separate buildings, one for each barrack. Heat is provided by steam plants, one to each regiment. Steam pipes between buildings are carried overhead on poles placed 21 ft. centers. Hot water for the shower baths is provided by heaters connected with the steam heating plants.

Water Supply

The water supply of the camp is derived from eight 10-in. driven wells which penetrate the Marshall sand stone. These wells average 110 ft. in depth and rock was struck at from 50 to 60 ft. below the surface.

Pumping and Storage

The pumping equipment consists of two pumping stations, each equipped with vertical centrifugal pumps direct connected with 220-volt, 3-phase, 60-cycle A. C. motors. The low level station, located at the wells, is further equipped with two electrically driven vacuum pumps for priming purposes and an emergency sterilizing outfit consisting of two liquid chlorine machines. The last mentioned devices were found to be invaluable in the cleansing of the distribution system when it was put into service. A thorough cleansing of the pipes was made necessary by the fact that a river crossing was made and that 2,000 ft. of the supply line was laid through a swamp.

The river station lifts the water to a hill near the camp, where are located four redwood tanks, each with a capacity of 200,000 gal. The high-level or booster pumping station is located at this point. The equipment at this station consists of seven vertical centrifugal pumps, direct connected, with a recording Venturi meter. The pumps are so connected that they can draw from the supply main direct or from any one or all of the storage tanks. It will undoubtedly not be found necessary to run the booster station except in case of peak load and at times of fire. The elevation of the tanks is such that sufficient pressure for ordinary use is obtained by gravity. The system was designed on a basis of 55 gals. per capita for about 40,000 men. A recent pump test showed that with two pumps running at the well station 2,600,000 gals. of water was obtainable per 24 hours.

Distribution System

The distribution system consists entirely of wood-stave pipe ranging in size from 6 to 12 in. The system is of the gridiron type and there are no dead ends except a few lines among the stables, and these are for fire protection only. All dead ends are provided with hydrants.

Sewerage System

The sewerage system is built entirely on the separate plan and consists of about 110,000 ft. of salt-glazed vitrified bell and spigot pipe ranging in size from 6 to 30 in. Cement and oakum joints were used, and they worked out very well, as the trenches were all in dry sand and no infiltration is to be expected.

The following minimum grades were used. They give a velocity of 2 ft. per second, flowing full, by Kutter's formula with n=13:

Diameter of Sewer, in.	Minimum Grade.
6	.5%
8	.36%
10	.28%
12	.20%
15	.16%
18	.14%
22	.12%
24	.10%
27	.08%
30	.07%

Sewage Pumping Station

Due to the topography it was necessary to construct one small pumping station and to divide the main collecting system into two separate sections, each with its outfall sewer and treatment plant.

The pumping station cares for three of the ten infantry regiments and consists of a pump pit and wet well. The pumping equipment is composed of three horizontal centrifugal pumps direct connected to 220-volt, 60-cycle, 3-phase A. C. motors, float controlled. There are two 4-in. and one 6-in. pumps in this station. The force main is 12-in. wood-stave pipe, 1,800 ft. long, and discharges into the high end of the main collecting system.

Sewage Treatment

The ultimate means of disposal is the Kalamazoo River, but before discharging the sewage into the river it passes through grit chambers and settling tanks. Grit chambers were provided because of the sandy nature of the soil and of the training given the recruits, which makes it inevitable that considerable quantities of sand will cling to their clothing and bodies, thus making the drawing of the sludge from the settling tanks a difficult procedure. The sludge will be disposed of by ditching, for the present at least.

Trenching

Trenching for water and sewer pipes was done by machine. Water pipes were laid with 5-ft. cover. The depth of sewers ranged from 4 to 17 ft., with an average of about 7 ft. As high as 3,900 ft. of sewer was laid in one day of ten hours with five machines. Less than 1,000 ft. of ditch and water pipe laid was considered a poor day's work for machine and crew. The largest amount of ditch cut by any one trencher in ten hours was 1,900 ft., 5 ft. deep. Eight trenching machines were in use on the work and 20 mechanical back fillers.

Personnel

Construction of the camp was under the supervision of Major E. B. Morden, Q. M. C., U. S. R., Construction Quartermaster; J. L. Lee, Supervising Engineer, and Samuel A. Greeley, Consulting Engineer on Water and Sewerage. The writer acted in the capacity of assistant and designing engineer of the sewerage system.

Bridges and Buildings

Design and Construction of the Third Avenue, South, Concrete-Steel Arch Bridge, Minneapolis, Minn.

By Chas. F. Bornefeld, Resident Engineer for Concrete-Steel Engineering Co., Consulting Engineers, New York City.

The new Third Avenue South Concrete-Steel Arch Bridge in Minneapolis is nearing completion, as the accompanying views show. The bridge is 2,223 ft. long and consists of seven main river spans. The bridge is partly curved in plan and has arches of two types. The 211 ft. spans have three arch ribs carrying crosswalks, and the 134 ft. spans have barrel arches. All arches are reinforced by steel truss ribs. The concrete was placed from a cableway of 2,038 ft. span, through drop-bottom buckets.

The bridge spans the Mississippi River. Because of its size and the difficulties encountered on the construction the bridge has features of interest to engineers and contractors.

Troublesome geological conditions led to the adoption of a partially curved plan. The formation at the site consists of limestone ledge rock about 15 ft. thick. This rises almost to the water in the west channel and is covered with a few feet of silt and sand in the east channel. The limestone is underlain by St. Peter sandstone in a bed 600 ft. thick. This sandstone is soft enough to loosen easily under the pick and is readily eroded by water under pressure. The ledge of limestone extends about 500 ft. upstream and about 700 ft. downstream to the crest of St. Anthony Falls.

Why Plan is Curved.

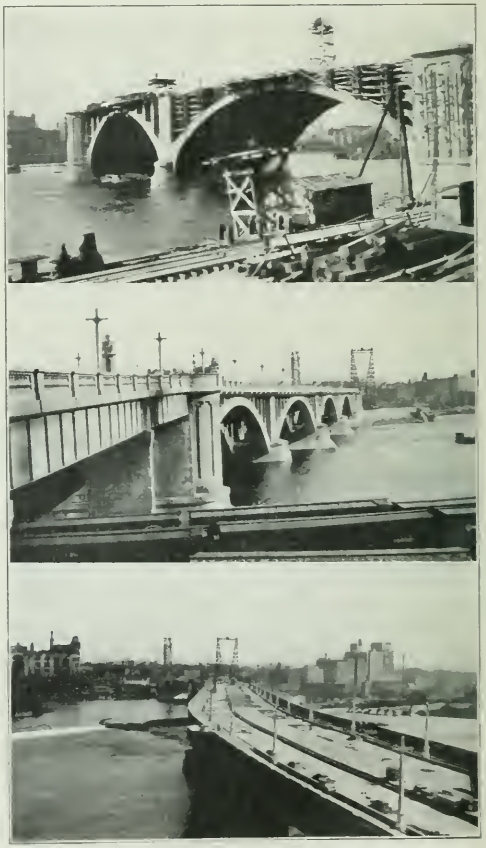
Conditions of unusual interest in the rock led to the location of the piers which made necessary a partially curved plan. Years ago tunnels were driven through the soft sandstone so that power from St. Anthony Falls could be utilized in the construction of public works. The water was led from the mill pond in a canal above the limestone and the tunnels served as tailraces. In 1869 one of these tunnels had reached a point near the foot of Nicollet Island (2,000 ft. from the point of beginning), when water poured in from a break in the overlying bed of limestone. The project was abandoned, and the United States Government made extensive repairs to close the break in order to insure continuance of the water-power and restore the original conditions as far as possible. Another break occured in 1876. The locations of these breaks in the river bed and their relation to the bridge site controlled the location of the bridge piers and this determined the alignment of the structure.

For years there has been a strong demand for a bridge in this locality. A handsome structure was desired and a concrete arch structure was considered the best type and was chosen.

The bridge is 2,223 ft. long and consists of seven main river spans. It has a 54-ft. roadway (with double-track street railway) and two 12-ft. sidewalks. The loading provides for two 40-ton cars and 100 lb. per sq. ft. uniform load. The floor system is designed to carry a 24-ton road roller on a space of 12x18½ ft. The center line starts at the intersection of Third Ave. South and First St. at an angle of 21 deg. 39 min., and is on a tangent for 151 ft. to a 4-deg. curve 330.2 ft. long. A tangent 719 ft. long continues to a curve consisting of a 4 deg. compound into a 10 deg. curve in a distance of 526.83 ft., bringing the center line of the bridge to that of First Ave. Southeast. The bridge is level, with the grade of 0.9% on the east approach and 3.4% on the west approach.

There are five 211-ft. spans with piers 20 ft. wide as springing line and two 134-ft. spans with an intermediate pier 13.79 ft. wide. The two end, or abutment, piers and the pier between the 211-ft. and 134-ft. spans are 30 ft. wide. The approaches are steel girder spans on thin piers. All the river piers are skew to the center line. The 211-ft. spans are on the tangent of the 4 deg. curves and the 134-ft. spans are on the 10 deg. curves.

Each of the 211-ft. spans is carried by three arched ribs of



VIEWS OF THIRD AVENUE, SOUTH, CONCRETE-STEEL ARCH BRIDGE, MINNEAPOLIS, MINN. UPPER—SPANS 8 AND 9 SHOWING TRANSVERSE WALL FORMS AND FLOOR SLAB FORMS. MIDDLE—PERSPECTIVE VIEW SHOWING LAMP POLES, BRACKETS AND TWIN CABLEWAY TOWERS. CLEAR SPAN OF CABLEWAYS 2,036 FT.; MAX. LOAD PER CABLE 10 TONS; WORKING LOADS 6 TONS. LOWER—TOP VIEW OF STRUCTURE SHOWING CURVATURE ALIGNMENT.

36-ft. rise, of reinforced concrete. The outside ribs are 12 ft. wide in the two end spans and 10 ft. in the intermediate spans, while all center ribs are 16 ft. wide. The reinforing is of the Melan type, consisting of ribs 4x4x4½-in. angles laced with 3x3x$\frac{5}{16}$-in. angles (at haunches) and 2½x⅜-in. bars. There are six of these ribs in each 16-ft. arch rib, five in the 12-ft. and four in the 10-ft. ribs. They are braced every 30 ft. with 3x3x$\frac{5}{16}$-in. angles. The two 134-ft. spans over the east channel are full-barrel arches with Melan ribs of 3x3x$\frac{5}{16}$-in. angles laced with 2½x¼-in. bars. These are spaced 34 in. c. to c. and cross-braced every 30 ft. with 3x3x⅜-in. angles. Carrying the floor system from the ribs are transverse walls and girders supporting the floor slab and brackets supporting the sidewalk slabs and parapet-wall beam. Air was used for riveting.

The grand total cost will be $800,000. The bridge will require 56,000 cu. yd. of concrete, 963 tons of structural steel for the arch ribs, 800 tons of reinforcing bars for piers and 1,600,000 ft. of lumber for centering. The prices for materials delivered at the site were as follows: Crushed traprock, $1.45 per cu. yd.; washed sand, 75 cts.; cement, $1.20 per bbl.; structural steel (including erection bolts and nuts), $53.50 per ton; reinforcing bars, $1.429 per 100 lb.; Lackawanna 7-in. steel sheetpiling, $1.63¾ per 100 lb.; coal (lump), $4.15 to $4.25 per ton; electric current for light and power, 2.9 cts. per kw.-hr.

Personnel.

The construction of the bridge is being done by the City of Minneapolis under the day labor plan and, as is the case with all of the City Work, is under the direct charge of the City Engineering Department.

VIEW OF THIRD AVENUE, SOUTH, CONCRETE-STEEL ARCH BRIDGE, MINNEAPOLIS, MINN.

The original sketches and studies as well as all the used surveys were made by the Concrete-Steel Engineering Company of New York who also drew up the full detail plans and the specifications, and supervised the construction. Mr. William Mueser, Mem. Am. Soc. C. E. is directing head of this company. Mr Henry Hornbustel was the consulting Architect and Mr. Chas. F. Bornefeld C. E., the resident engineer on the work for the Company.

The construction forces were under the direction of the City Engineer, Mr. Frederick W. Cappelen, Mem. Am. Soc. C. E. with Mr. Wm. Elsberg, Assistant Engineer and John Lundstrum general foreman. The City Engineer also had the general direction of plans and the supervision of the structure was performed under his general direction.

The early spring is now being designated as the time for completion and for opening the bridge to traffic. There still remains some 2,000 cu. yds. of concrete to place and the wood block pavements and sidewalks to lay.

WATER PURIFICATION AND SEWAGE TREATMENT

Some Conclusions Reached at Milwaukee on Treatment of Sewage by Activated Sludge Process

In the activated sludge process as in all other methods of sewage treatment, the character of effluent required is one of the first questions to decide, for upon it depends the size of plant and the air required to operate it.

If the removal of the matters in suspension and the production of a clear effluent are all that are required, less aerating tank capacity and less power should be provided; whereas, if the effluent must be not only clear but well nitrified, the sewage must be given a longer period of contact with the air and sludge and a greater volume of air per gallon of sewage treated must be used.

In an aerating tank having 15 ft. effective depth of liquor 98% removal of suspended matters can be effected with .5 cu. ft. of air per gallon of sewage treated applied for one hour. On the other hand if nitrates are to be produced in the effluent the same sewage will require from .75 to 1.10 cu. ft. of air per gallon applied from four to six hours.

The cause of this result is that the agitation of the liquor by the air separates the solids and collodial matters very rapidly but it takes time for the bacteria contained in the activated sludge to convert the ammonias into nitrates and these in turn to nitrates.

Preliminary Processes Desirable

Should the sewage to be treated be combined with storm water, grit chambers should be installed of such a design as effectually to exclude from the aerating tanks all grit.

The sewage from an industrial community colleoted either by a separate or combined system of sewers should be fine screened before passing into the aerating tanks.

Grit in the aerating tanks settles to the bottom and rests upon the air diffuser plates, interfering with their efficiency. All industrial sewage carries quantities of waste, fleshlings, pieces of leather, packing house wastes, large pieces of paper and textiles of many kinds, lime and hair. When in the aerating tanks these things form masses of great specific gravity, settle upon the diffuser plates and interfere with their efficiency. If they are carried over to the sedimentation tanks they frequently stop up the sludge draw off pipes and valves and thus disturb the continuous operation of the plant.

In addition to the above objections, the decomposition of

the organic matter contained in these articles requires large quantities of air, which is a more expensive media than can be utilized in other forms of sludge reduction. We found at Milwaukee by means of experiment that we could save from 15% to 20% of air when treating sewage passing through a 20-mesh screen as compared with the same sewage passing through a 1-in. grid screen.

Where a purely domestic sewage is to be treated by the activated sludge process, the author is not so sure that fine screening would be necessary. In any case, however, he believes that a 3-16-in. slotted screen is quite fine enough for any character of sewage.

Type of Acrating Tank

Local conditions will largely influence type of aerating tank. The size of the plant may also have its effect upon the design. In order to reduce construction cost, simplicity of design should be closely adhered to. After determining the period of retention in the aerating tank and the volume of liquor to be treated the tank should be proportioned to give the greatest length of flow possible without wasteful use of piping and concrete.

The greatest length of flow tends fully to utilize the law of average in tank efficiency. For instance, if a tank is 100 ft. long and 22 ft. wide having 17 rows of diffuser plates spaced about 6 ft. centres across the axis of the tank it will have a greater efficiency than one 50 ft. long and 44 ft. wide with 8 rows of diffuser plates, because in passing thru the first tank the liquor must pass twice as many air baffles as when passing through the last tank and the changes of direction will be correspondingly increased. In the last named tank more efficiency could be obtained by dividing it into two separate compartments by a central baffle wall, applying and taking off the liquor at the same end.

Our tanks in Milwaukee are to be 350 ft. long and 22 ft. wide, the liquor being applied at one end and removed from the other.

Piping

The piping system of the activated sludge process being an expensive feature, due attention should be paid to it in the design. All valves should be placed so as to be easily reached, and all air piping should be of such a type as to preclude inside corrosion. Iron rust gets into the pores of the air diffusers and reduces their efficiency. Therefore, cast, galvanized, or Sherrardized iron pipe or lead should be used for conveying air thruout the plant.

The bottom of aerating tanks should be of saw tooth, or similar form, with slopes of from 1 to 1 to 1 to 1.5, with the air diffusers placed in the gutters. The object is to allow no flat places upon the bottom upon which sludge could rest and become septic.

The air diffusers may be placed in cast iron or concrete containers, preferably the latter, both on account of less cost and no tendency to corrode. If cast iron containers are used they should be given a good coat of pitch while hot, care being taken to place the diffusers in the containers in such manner as to secure air-tight joints and permit of their removal and replacement without damage.

Type of Sedimentation Tank

Sedimentation has been given greater study at the Milwaukee Testing Station than any other feature of the process. Many different types of tanks have been operated for the purpose, primarily, of determining the best type of tank, flowing thru velocity, area, depth and sludge removal. Without going into the minute details of these experiments, it will perhaps be sufficient to state the general conclusions warranted by these experiments.

The running through velocity should not exceed three feet horizontal per minute. The detention period may be from thirty to fifty minutes according to character of sewage treated. Vertical-horizontal flow is more efficient than vertical or horizontal.

The effluent must be removed with the least velocity possible and over continuous rather than V-shaped wiers. The latter cross-currents just when they are most objectionable. Cross-currents must be avoided so far as possible.

The influent must be introduced back of a baffle at least four feet below surface of liquor in tanks. The flow should be across the narrow section of the tank. Too long a depth of flow tends to pick up the lighter particles of sludge and carry them over with the effluent.

A baffle should be placed back of the effluent wier extending a few inches below the liquor surface: This is to prevent the fats, match sticks and other light substances, which float upon the surface of the liquor, from passing out with the effluent.

The depth of the tank is not material except that it shall be sufficient to allow capacity for the settled sludge to be drawn off without abnormally increasing the under-currents near the level of the bottom of the influent baffle due to the suction of sludge passing from the tank.

An area of 1 sq. ft. for each 1,600 gal. of well aerated sewage should be provided. The less the aeration the greater the area required.

The tanks may be either hopper or flat bottom, as desired and the sewage may be removed by air lifts or hydrostatic pressure. If hopper bottom the slopes must be from 1 to 2 to 1 to 3 to keep the sludge moving towards the draw off pipe.

If the flat bottom is used some apparatus must be provided to remove the sludge settling on the bottom to a draw-off pipe. This may be done by a Dorr thickener, or similar device, or by a squeegee mechanically operated from the top of the tank.

In the Milwaukee Station the last two mentioned devices have been tried out with satisfactory results. They insure a clean tank, thicker sludge and less tank depth. Returning thicker sludge to the aerating tanks means reduction of air.

In localities where deep tanks would greatly add to expense of construction, the mechanical devices above mentioned would probably be advisable.

Type of Air Diffusers

Several types of air diffusers have been tried out at the Milwaukee station, prominent of which are field tile, thin wood blocks cut cross-grain, perforated pipes and filtros plates of different porosity.

Filtros plates as manufactured by the General Filtration Company of Rochester, N. Y., are porous plates 1½ in. thick made up of graded sand and burned in kilns under high temperatures. They can be made of any degree of porosity required, are stable in character, and are, by all means, the most satisfactory air diffusers we have used at Milwaukee.

Ratio of Air Diffuser and Tank Surface

Ratios of from 1 to 4 to 1 to 10 have been used in United States and England. The latter inclines towards the greater ratios. It is the author's opinion that the economical ratio largely depends upon the type of aerating tank used and the character of effluent required.

In a short flowing through length a ratio of 1 to 4 or 1 to 5 would prove more efficient thus decreasing the tendency of short-circuiting the passing liquor; whereas in long flowing through tanks a greater ratio could well be used because the law of averages are thus better utilized.

The higher standard effluent required the smaller the ratio, for the same reasons as above stated. The author has de-

termined to use a ratio of 1 to 6 in the Milwaukee plant, where the tanks are 350 ft. long and must produce a high standard effluent.

Period of Aeration

This factor largely depends upon the character of sewage to be treated and effluent to be produced.

A mixture of domestic and industrial sewage can be well clarified, that is, to contain not more than 5% of the suspended solids in the original sewage in one hour's aeration by using from .5 to 9. cu. ft. of free air per gallon of sewage treated. To maintain this clarification, however, it is necessary to further aerate the sludge removed from and returned to the aerating tanks.

This proceedure, however, saves air because the sludge aerated is only 1/3 to ½ of the total volume of sewage treated.

To produce an effluent containing nitrates and from four to six parts of dissolved oxygen, with a reduction of bacteria of from 95 to 98%, from the character of sewage named, requires from four to six hours aeration. After such period of aeration there seems to be little or no advantage obtained from re-aerating the sludge, probably because it is maintained in prime and active condition by the period of aeration above stated.

Period of Sedimentation

The period of sedimentation is closely connected with the period of aeration, assuming the sewage treated to be of similar character. Low period of aeration requires longer period of sedimentation.

Well activated or well aerated sludge flocs very rapidly and settles out of the liquor at the rate of one vertical inch per minute, whereas poorly aerated sludge flocs slowly; in fact, the finer particles seem incapable of flocculating.

While the period of sedimentation is a factor to be considered, the principal factor seems to be the area provided, as has already been mentioned.

From 30 to 50 minutes are sufficient to clarify the sewage providing the sludge is removed from the sedimentation tank as rapidly as it settles.

Volume of Air Required

The volume of air required depends upon several primary factors, such as the character and quantity of organic matter in the sewage, depth of aeration tanks and the character of effluent required. To some extent the temperature of the sewage below 50 deg. F. also has its influence if continued over a long period.

Inasmuch as the chief expense in operating the activated sludge process is the cost of the power producing the air the quantity required should be carefully determined in each case and the entire plant designed and operated with a view of reducing the air consumption to the economic limit.

The author is of the opinion that the Milwaukee sewage can be successfully treated to produce an effluent showing 90% removal of bacteria, 95% removal of suspended matter and 72 hours stability by using 1.5 cu. ft. of air per gallon of fine screened sewage in a 10-ft. deep tank, and 1.1 cu. ft. of air per gallon in a 15-ft. deep tank using from 15 to 25% of activated sludge in the aerating tank. Screens to have from ⅛ to $\frac{3}{16}$-in. slots.

Percentage of Activated Sludge

This factor is not a very important one within certain limits. We have obtained equal results when using 15% to 25% of activated sludge in the aeration tank. Indeed it is quite fortunate that this is true, for without extremely close supervision it is impossible to maintain an uniform percentage of sludge in the plant.

About 20 percent of well activated sludge is all that is required for satisfactory treatment. This percentage is measured in a beaker after one-half hour's settlement, after which the settled sludge contains about 99% of moisture.

Volume of Sludge to Be Handled

Of course this factor largely depends upon the suspended matters in the raw sewage and the period of aeration given. As stated immediately above the volume of sludge fluctuates very much and averages only can be considered.

Basing our assumptions upon experiments we are providing in our final plant at Milwaukee to produce from each million of gallons of raw sewage treated 55,565 gallons of sludge containing 99.5% moisture, 10,250 gallons containing 98% moisture, 8,305 pounds of pressed sludge cake containing 76% of moisture, and 2,076 pounds of dried sludge containing 10% moisture.

Removing Sludge From Sedimentation Tanks

Several methods have been carried out in Milwaukee for removing the sludge from the sedimentation tanks.

It is the author's opinion that the removal of the sludge by mechanical means will largely reduce the first cost of plant and produce a much more satisfactory and uniform effluent. While pumping the sludge by air increases to some extent the oxidation of the sludge and maintains it in a well fluctuated condition, the expense over pumping with centrifugal pump overcomes these advantages.

Value of Sludge

Estimating one ton of dry sludge can be obtained from one million gallons of raw sewage treated, and an average daily dry weather flow of 85,000,000 gallons, the net cost of disposing of Milwaukee's sewage is estimated at $9.64 per million gallons, of which $4.89 is chargeable to overheads, and $4.75 to operation, renewals and repairs. The 85 million gallons of sewage per day is expected to be produced from a population of 589,000 and the net cost of operation including overheads and maintenance, is 53 cts. per capita.

Elimination of Odors

There is no offensive odor connected with the activated suldge process of sewage treatment, but considerable odor may attend the improper methods of sludge reduction.

Partially dewatered sludge, if exposed to the sun for a few hours, gives off a highly objectionable odor of sulphuretted hydrogen. This odor lasts for a short time only, or until a dry covering is formed. Sludge placed under cover and not exposed to sun or wind gives off but little odor.

In drying the sludge through a direct heat dryer a very offensive odor is thrown off with the hot gases of combustion. To overcome this effectually the gases must be run through a dust box, thence through a condenser, and the insoluble gases escaping from the latter should be discharged into a furnace immediately under the fire grate.

Neither flies, insects nor worms inhabit the treatment plant even during the early fall when they are so prevalent in nearly all other types of disposal plants.

Conclusions

The foregoing statements have been made as the result of observations and studies of the operation of the sewage testing station at Milwaukee covering a period of three years, during the last half of which has been almost exclusively confined to the activated sludge process.

The author feels that while there are many phases of this process yet to be determined which can be done only after operating a large plant, the important factors which influence the adoption and design of the plant have been proven.

In situations which require a high standard effluent the most satisfactory process in use today is sedimentation followed by percolating filters. The separate features of this process have been developed from year to year during the past decade

until it may be said that it has reached its limit. Even so the sludge problem has not been satisfactorily solved where large plants are to be considered, inasmuch as the constant accumulations of partially dried and half decomposed sludge is bound to create in the future a nuisance difficult to handle in a sanitary manner.

The only other process known to the author which can produce an effluent comparable with percolating filters is the activated sludge process, which, when developed to the extent possible and very probable within the next decade, will doubtless supersede the filters.

There are many advantages in this new process which must be considered, among which are small area, lower first cost, and final disposition of the troublesome sludge.

As compared with percolating filters treating a maximum rate of 3,000,000 per acre under favorable climatic conditions the activated sludge process can treat 10,000,000 gallons per acre under the most unfavorable climatic conditions.

The first cost of construction is more for the percolating filters than for the activated sludge process, and little difference is expected in the cost of operation.

The Milwaukee plant, as designed, is estimated to cost $44,000 per million, exclusive of engineering and pumping, and $4.75 per million gallons operating cost. This first cost embraces prices for labor and material which did not prevail when the percolating filters above alluded to were built.

Mr. E. E. Sands, City Engineer of Houston, Texas, has just completed an activated sludge plant, (exclusive of sludge disposal) to treat 12 million gallons at a cost of about $24,000.00 per million, and expects to install the sludge disposal features for $40,000.00, the balance of his appropriation.

The high nitrogen content in the sludge produced from the activated sludge process warrants the expense necessary to reduce it to a fertilizer basis, and thus the sludge problem is effectually solved without nuisance.

The absence of odors, flies and other insects is no small advantage. The former advantage frequently enables the engineer to eliminate long expensive outfall sewers. The small loss of head through the process frequently obviates pumping as is so often required in the percolating filter process.

Throughout many of the discussions between engineers relating to this new process the cost of power has been one of the stumbling blocks. In a small plant treating less than five million gallons per day the cost of producing the power might prove too expensive, but where larger plants are under consideration power can easily be produced for less than one cent per horse-power hour. Such a cost will make the cost of operating the process upon an equality with the percolating filters.

Acknowledgment

The foregoing matter is from an address to the American Public Health Association by T. Chalkley Hatton, Chief Engineer, Milwaukee Sewerage Commission.

Refuse Collection and Disposal

Recommended Methods for the Collection and Disposal of Refuse in Louisville, Ky.

By Samuel A. Greeley, Hydraulic and Sanitary Engineer, 64 W. Randolph St., Chicago.

The recommendations here made are the result of field inspections made in Louisville by the author and Frederic Bonnet, Jr., of Worcester, Mass., who was secured as special assistant on this work. The report was made to and paid for by the Woman's City Club of Louisville, Ky.

The refuse materials, whose treatment is considered in the report, are: Garbage, ashes, rubbish, tins and mixed refuse. The treatment of stable manure was the subject of special report.

Four Parts of Refuse Disposal Problem.

There are four equally important parts or phases of the refuse disposal problem, as follows:

a—The so-called "House Treatment," which includes the degree of separation, the type of house can, the location of the can and such other items relating particularly to the work of the householder.

b—The "Collection" is the various materials.

c—The "Secondary Transportation" of the refuse materials after they are collected and delivered to one or more central points.

d—The "Final Disposal" of the refuse after collection and transportation.

All of these parts are equally important, but the collection is most costly. In the solution of the refuse disposal problem due consideration should be given to each phase, so that each one will co-ordinate with the others. In fact, the most important element in the refuse disposal problem is the development of a complete system, starting with the ordinances and continuing through the house treatment, collection, transportation and disposal. Many different methods of refuse disposal are in successful operation in various cities. The extent to which the service is satisfactory to the householder, however, depends upon the completeness with which the service as a whole is developed and operated.

VIEW OF WELL-KEPT REFUSE DUMP IN ST. LOUIS, MO.—NOTE RESIDENCE IN DISTANCE.

Efficient Operation Essential.

The operation of refuse collection and disposal work is of such importance as to warrant a special comment. A refuse

disposal plant is not of itself a proof against odors and nuisances. Faulty or careless operation will result in more or less odor in any plant. Unclean wagons will largely defeat an otherwise well planned system. Improper house treatment will make it difficult and some times impossible for the collection service to maintain each district in a clean and sanitary condition. Therefore efficient management and operation is essential.

House Treatment and Collection.

It is a common experience to find public attention directed first toward the method of final disposal. It is to be questioned, however, whether this phase is relatively as important as the house treatment and collection. On a cost basis the collection is the most important. From the aspect of neighborhood cleanliness and comfort, the house treatment is of considerable importance. A fair conclusion is that each of the four phases of the problem are important and should be given equal consideration. The four phases are so closely associated with each other that a lack of proper coordination materially reduces the efficiency of the service and at the same time increases the cost.

Louisville Data.

Louisville has an area at present of 26.9 square miles. The larger dimension, in an east and west direction is about 8.0 miles, while north and south the city extends about 3.5 miles. The present estimated future population is as follows:

1910	225,567
1917	240,000
1920	255,000
1930	300,000
1940	345,000

We have estimated at present about 55,000 houses in the city. The city is built for the most part on rolling ground above the Ohio river, with a maximum rise over the river of about 160 ft. The population is comparatively compact at about 13.9 per acre. The city is comparatively well paved, containing 240 miles of pavement out of something over 300 miles of streets.

The present total assessed valuation of Louisville amounts to about $211,000,000. The outstanding bonds amount to $12,391,500, or about 6.0 per cent. of the valuation. Additional bonds up to 4.0 per cent. of the valuation, or about $8,000,000, could therefore be issued, if given a favorable popular vote, and provided the annual revenue could be increased sufficiently to meet the interest and sinking fund requirements.

Present Collection and Disposal Methods.

The collection and disposal of refuse in the City of Louisville is at present handled by the Board of Public Works, through the superintendent of the Street Department. Mixed garbage, ashes and rubbish are placed by the householder in the same receptacle and these receptacles are set out on the sidewalk for the collector. Collections are made in wooden wagons, drawn by two horses and served by two men. The refuse so collected is hauled to twelve dumps, scattered throughout the city. The ordinances covering this work are complete and do not bear directly on the refuse disposal problem.

Each dump has a dump boss, whose duties are to oversee the dump, sign tickets for wagons and direct the wagons where and how to dump. These dumps are usually offered the city by property owners who wish to have their property filled. The dump boss makes arrangements with scavengers for their help in covering the dump, as compensation for which they receive certain picking privileges. Bread, clothing, bottles and other marketable articles are picked out in this way. During July, 1917, there were about 600 hogs running loose on the various city dumps and feeding on the garbage contained in the refuse.

Some attempt is made to cover and level the dumps with dirt and street sweepings, and at times carbolic acid and creosote are used to reduce the fly nuisance. These dumps, however, are not maintained as well as they should be.

Data Gathered in Field Investigations.

Under our direction a substantial amount of field investigations have been made. As regards house treatment, it was found in the district studied that 17 per cent. of the receptacles set out were cans, the remaining 83 per cent. being barrels, baskets, pails and other various vessels.

At 43 per cent. of the houses visited the collections were made once a week and at 33 per cent. of the houses twice a week. The three times per week collection reached only 24 per cent. of the houses.

Out of a total of 495 collections observed 371, or 75 per cent., were from receptacles set out on the curb. The receptacles were set out for the collector with great regularity, but not as frequently as might be. The wagons were available for more frequent collections. The records indicate that the collectors quite frequently went into the back yards for the receptacle.

FLY CAGES AT GARBAGE BURIAL FIELD, WORCESTER, MASS.

Time Studies.

Time studies were also made of the work of the collection wagons. Wagons are able to make from 4 to 6 loads per day. The actual time loading amounts to about 27 per cent. of the total working time, the remaining 73 per cent. being spent in hauling and unloading. This data points clearly to the advisability of using larger wagons to reduce the number of trips per day, and thus to reduce the unproductive time spent hauling and to increase the productive time in actual collections. The average time per collection was 22 seconds, which was very rapid. The average number of houses visited per wagon per day is about 225, which could be increased by the use of larger wagons.

The dumps were not sufficiently trimmed and covered. There was too much uncontrolled scavenging and hogs were allowed to run loose. The result was most unsightly. Many flies developed, but odors were not pronounced during our inspections.

The available records of the number of wagon loads of refuse collected each day since the year 1910 have been secured and tabulated. On the basis of an average weight per load of 1,200 lbs., these records indicate a production of mixed household refuse of 825 lbs. per capita per year. Based on Louisville conditions and on comparison with refuse quantities

in other cites I have estimated the quantities of refuse which will have to be handled in Louisville as given in Table I.

Table I—Estimated Quantities of Refuse to Be Handled.

Material.	1920 Average.	1920 Maximum.	1930 Average.	1930 Maximum.
	——Tons Per Day——			
Garbage	72	108	80	120
Ashes	238	380	280	450
Rubbish	33	40	40	48
Mixed Refuse	343	446	400	520

The estimate given in Table I should be checked up by taking actual weights of the refuse as now collected over a period of about a year.

There is a marked seasonal variation in the production of these refuse materials which it is necessary to consider in the planning of the refuse disposal system. Louisville refuse appears to be somewhat lower in quantity per capita than in other cities located to the north, where accurate weight records are kept. In my opinion the garbage will run slightly below the average in its content of grease and tankage and the mixed refuse will have a comparatively high calorific value.

No study of the refuse disposal problem can be carried out thoroughly unless the principles of the problem are appreciated. A comparison of the various methods of refuse disposal must include all the factors and phases involved and a balance struck on both sanitary and economic lines.

The frequency of collection depends largely on the funds available. To give service three times per week will cost about 50 per cent. more than to give service twice a week. The first cost of refuse disposal is largely dependent upon the method of disposal and the annual cost upon the amount of collection service rendered. The cost of the house treatment is controlled by the number of cans required, and comes directly upon the householder.

Recommendations for Upkeep of Dumps.

In view of the present method of disposal by dumping in Louisville special recommendations have been given for the upkeep of dumps. Some classes of refuse are more easily disposed of by dumping than others. These are ashes, street sweepings, building excavations and other more or less inert materials. Large quantities of such materials will be disposed of in this way. Garbage is objectionable on dumps because of the number of flies and rats that are produced. Under proper direction rubbish may be safely disposed of on dumps. In cities having a large number of low places it is desirable to use some of the refuse for filling.

Among the special requirements for the upkeep of dumps are the following:

a—The dump should be filled so as to limit the dumping edge as far as practicable. The exposed edges are the most objectionable because of the difficulty of covering them.

b—A sufficient amount of ashes, street dirt, building excavation or borrowed earth should be secured to properly cover and level the dump.

c—Completed portions of the dump should be seeded and partially parked, as is frequently done (New Orleans, Nurenburg).

d—No scavenging should be allowed at the dump at any time except by city employees.

e—Portable rubbish burners should be kept at the dump to burn large, bulky portions of rubbish not suitable for fill.

f—A water pipe should be laid to each dump to bring water for use in putting out fires and for sprinkling to prevent dust.

g—A sufficient supply of kerosine, creosote or other fly germicide should be kept on hand so that any large number of fly maggots can be killed before developing into flies. In addition fly traps should be kept at the dumps, as done at Worcester, Mass., and here illustrated.

h—Only such garbage as cannot be readily kept separated from other refuse should be dumped.

i—The used portion of each dump should be enclosed with a light movable board fence, to facilitate control and prevent paper dust from blowing away.

j—The dump should be in charge of a uniformed foreman with authority to enforce the regulations.

To carry out these requirements funds are needed, but even with these necessary expenses disposal by dumping is less costly than by other methods.

In accordance with the general discussion of the refuse disposal as given in the report and the special data secured for Louisville, a number of projects for refuse disposal are described in the full report. It should be noted again that the most important feature of any project is the completeness with which it is planned and put into operation.

Estimates of Cost.

The house treatment, collection, transportation and final disposal must all be included and worked out to form a complete comprehensive system. If such a complete system is developed along sanitary lines, the particular method of refuse disposal adopted is not the most important feature. However, the estimates of cost indicate the preferable method of final disposal.

VIEW OF GARBAGE DUMP, LOUISVILLE, KY.

The estimates of cost have been made up on a conservative basis. However, it should be noted that under present market conditions estimates of cost are difficult to make, particularly to hold for any time in the future. Therefore, if construction is postponed for a number of months, closer estimates will be required in conjunction with definite sites. The estimates as given are on a uniform basis and serve for a comparison of the different methods of disposal.

A summary of the estimates of cost of different projects for refuse disposal for Louisville is given in Table II. Three projects have been made up on the basis of complete or partial incineration and three projects on the basis of the reduction of garbage and the disposal of ashes and rubbish by dumping and sorting. The most costly projects on an annual cost basis are those by incineration. These range from $0.98 to $1.08 per capita per year, including operation and fixed charges. The projects for reduction of garbage and dumping of ashes and rubbish range from $0.83 to $1.03 per capita per year, including fixed charges, based on normal prices for grease and tankage. At present market prices the garbage reduction project amounts to $0.61 per capita.

Table II—Estimated Cost of Refuse Disposal for Louisville, Ky.—Summary of Data.

Project. No.	Description.	First Cost.	ANNUAL COST Oper-ation.	Fixed Charges.	Total.	Revenue.	Net annual Cost.	Net capita annual cost.
I-a:	Mixed collections and Incineration	$539,000	$229.200	$ 52,155	$281,355	$ 31,355	$250,000	$0.98
I-b:	Two separations and partial incineration	320,800	244,100	32,116	276,416	.....	276,416	1.08
I-c:	Two separations and partial incineration	176,800	239,500	18,436	257,126	.....	257,126	1.01
II-a:	Two separations and garbage reduction	331,800	259,960	37,741	279,901	85,600	212,301	0.83
IIb:	Three separations, garbage reduction and rubbish sorting	398,300	317,960	45,328	363,288	100,000	263,288	1.03
II-c:	Two separations and garbage reduction by Cobwell Process	386,800	259,960	45,466	305,426	85,600	219,826	0.86
II-a:	See Above Revenue Figured on present market	.....	.....	.....	.....	143,800	.....	0.61

In view of these estimates given in Table II, I recommend that the city of Louisville undertake a complete refuse disposal system as follows:

a—House Treatment.

Proper ordinances should be enacted to provide for two separations of refuse, so that garbage may be collected in one set of wagons and ashes and rubbish in another.

b—Collection.

Special refuse wagons, adequate to the collection service required, should be purchased and maintained by the city. Teams and laborers can be hired. The wagons should be as large as the district conditions and character of refuse collected permit. Garbage should be collected at least three times a week in summer and twice a week in winter, with daily collections in special districts. If funds permit, more frequent service should be given. Ashes and rubbish should be collected from once to twice a week, as the season and district requires.

c—Transportation.

On the assumption that a garbage reduction plant will be located at some distance from built-up districts, secondary transportation of the garbage is included. The transfer stations should be built for clean and sanitary operation and special freight cars should be purchased.

d—Disposal.

Garbage should be disposed of by reduction and ashes and rubbish by dumping. Sufficient funds should be made available at once for the proper upkeep of the dumps and provision should be made for sorting out by the city of saleable rubbish. This would require a light building for paper baling presses and bins.

Reasons for Recommendations.

The following reasons for these recommendations are noted:

a—The project recommended offers the least costly system of refuse disposal, combined with sanitary operation.

b—Utilization of garbage and the recovery of portions of the rubbish meets with the present National program for the conservation of the country's resources. This is a desirable feature when it results in a true saving.

c—The dumping of ashes and rubbish provides a material for filling up lowlands in the city which areas would not be otherwise readily made available for use and also utilizes this natural asset of the city for economic disposal.

Tentative Working Program.

Pending the securing of funds, the purchase of sites and the construction of plants the following working program is suggested:

a—Make accurate weights of refuse as collected.

b—Prepare and adopt ordinances.

c—Readjust at once the operation and maintenance of dumps to provide sanitary upkeep, while all classes of refuse are thus disposed.

d—Make special tests of refuse wagons to determine the most economical size and design, so that the best equipment may be purchased at the time the new works are ready for operation.

e—Thoroly overhaul the house treatment, so that proper house receptacles will come into use.

f—Select and purchase sites and prepare plans and specifications for a garbage reduction plant and for rubbish sorting on the dumps.

These recommendations provide for an immediate improvement in the house treatment, collection and disposal, together with an opportunity for developing a complete and permanent system for refuse disposal. The City Officials should now continue this work as outlined and take proper steps to have the details of the plan worked out and put into operation.

FROM WORKERS IN FIELD AND OFFICE

Cost of Constructing Brick and Asphaltic Concrete Pavements in Kalamazoo, Mich.

THE EDITOR MUNICIPAL ENGINEERING:

Sir—

The paving engineer is always glad to receive information on the cost of construction in other cities. Very often the costs given are so general that they are not of much value. I hope that these may be of some value to the readers of MUNICIPAL ENGINEERING.

The City of Kalamazoo, Michigan, does all of the construction work in connection with its street paving, except laying the asphalt top on asphalt strets. The City is at present contemplating the purchase of an asphalt plant.

Types of Pavement.

All the work is done under the supervision of the Engineering Department. The two types of pavement having the largest amount of yardage at present are brick for heavy traffic streets and asphalt concrete (Topeka specifications) for residence streets. Both types are laid on a 6-in. concrete foundation. Most of the brick streets are filled with an asphalt paving filler.

Fig. 1 herewith shows men laying hillside brick on South West St. between street car track and curb. Fig. 2 shows a Chain Belt concrete mixer laying foundation on the same street at the foot of the hill.

Cost Data.

The itemized costs given below are for pavements laid in 1916, for 12,000 sq. yds. of brick laid on two streets, and 20,600 sq. yds. of asphalt concrete laid on five streets. The items given here are averages for each type of pavement. The different total costs on these streets did not vary over three cts. per square yard, so that the average can be taken as the cost for any one street.

The city paid 89 cents per sq. yd. for a 2-in. asphaltic concrete top (Topeka specifications), Bermudez asphalt, with a ten year maintenance guarantee. The city paid $1.36 net per barrel for cement delivered on the street, $17.27 per ton for asphalt filler f. o. b. Kalamazoo; for common labor 25 cts. to 30 cts. per hour, and for teams 56 cts. to 60 cts. per hour.

	—Cents—
Excavation	22.7
Concrete foundation:	
Cement	21.4
Gravel	13.3
Labor	8.7
Fuel	0.3
Mixer rent	2.0
	45.7
Asphalt top (contract)	89.0
Engineering & inspection	5.6
Total cost of asphaltic concrete per sq. yd...	$1.63

A. Lenderink, City Engineer.

Kalamazoo, Mich.

STREET PAVING VIEWS IN KALAMAZOO, MICH. LEFT—LAYING HILLSIDE BRICK ON WEST STREET. RIGHT—CHAIN BELT MIXER LAYING CONCRETE FOUNDATION ON SAME STREET.

Cost of Brick Pavement Per Square Yard.

	—Cents—
Excavation	29.5
Concrete Foundation:	
Cement	21.4
Gravel	13.3
Labor	8.7
Fuel	0.3
Mixer rent	2.0
	45.7
Brick	86.0
Unloading & cartage	9.0
Sand	3.2
Laying and culling	11.3
	109.5
Filler	8.70
Unloading & cartage	0.35
Pouring	5.30
Fuel	1.00
	15.35
Engineering	5.00
Total cost of brick pavement per sq. yd...	$2.0505

The depth of excavation for the brick pavement averaged two feet.

Cost of Asphalt Concrete Pavement per Square Yard.

The excavation averaged one and one-half feet.

Oregon State Highway Commission and Contractors Pleased With Cost Plus Percentage Contracts

The Editor of Municipal Engineering:

Sir—

There is now before the Oregon State Highway Commission, either under construction or authorized for construction, 42 different projects in the state, approximately $2,250,000 in cost, and in addition to this there are 17 projects covering road construction in conjunction with the U. S. Forest Service, approximating $1,114,000 in cost.

Plans and specifications, advertisments and, in a number of cases, a large portion of the surveys necessary to start these projects have been made by the department since June 4th of this year, when the bond issue was voted.

At the meeting of the Commission on November 6, proposals were received for the construction of 5 miles of highway from Hood River to Mosier (a section of the celebrated Columbia River Highway) which it was estimated would cost $352,000. At the same meeting, proposals were received for the improvement of two very dangerous sections of the Pacific Highway in Douglas County. These are what are known locally as the Roberts Mountain section, nine miles south of Roseburg, and the Wolf Creek-Grave Creek section near the Douglas-Josephine County line. In the neighborhood of $300,000 was the estimated cost of this improvement. With other improvements that are under way, including one very bad stretch on the Pacific Highway in the vicinity of Canyonville in the Umpqua

National Forest, which is to be taken care of by the Forest Service in cooperation with the state, this will make the Pacific Highway practically safe for travel by next season, as this work will be started at once and probably completed by June 1 of next year.

A portion of the work being handled by the department is being done on a force account, plus percentage basis. Owing to the fact that construction work is so greatly affected on the Pacific Coast by war conditions, it has seemed practically impossible for many contractors to find a basis on which to make a unit price proposition, and on the urgent request of a number of these contractors the work was let on the cost plus percentage basis in an endeavor to try out this method of handling construction work for the information of the commission in handling the larger volume of work which will come up during the year 1918. So far it seems to be a very satisfactory method, all conditions being considered, both for the contractor and for the state.

Very truly yours,

OREGON STATE HIGHWAY COMMISSION,

Salem, Oregon. G. ED ROSS, Sec'y.

Rapid Progress Made in Laying Monolithic Brick Pavement

The Editor of MUNICIPAL ENGINEERING:

Sir—

The accompanying view shows my gang laying monolithic brick pavement. It will be noticed that there are only three men in the grouting gang following the brick gang. The brick gang has eight men and they used a Mathews gravity brick conveyor. In a 10-hour day this gang completed from 800 to 1,000 sq. yds. of pavement. Another gang laid the concrete base for the pavement. I sublet the contract for laying the brick and grouting from Daniels & Lyst at Anderson, Ind.

This gang of grouters and brick layers is fairly permanent and specializes in laying, rolling and grouting brick for monolithic and cement-sand cushion brick pavements. Using this gang, I take subcontracts for this part of brick paving jobs. The general contractor lays the concrete base and we follow as closely as possible with the brick laying. We take all risk of delays to the concreting gang and the plan has been a money-maker both for us and the general contractor.

ECONOMICAL PLANT AND GANG FOR LAYING BRICK PAVEMENT.

Two men in the brick gang lay the brick and are paid 50 cts. an hour. It is up to the rest of the gang to keep up with the brick-layers. The gravity conveyor helps get the brick to the layers. The grout is mixed in a 2-wheel, flat-bottom trough, which holds a 1-bag batch. Two men mix the grout with hoes and when the mixture has attained the right consistency the mixing box is upended and the entire batch is allowed to run over the brick. The grout mixing box and the mixers are shown in the picture, as is also the man who spreads the grout with a 4-ft. squeegee.

Very truly yours,

Marion, Ind. C. F. GREEN.

Road Building Stimulates Business and Facilitates Its Processes

The Editor of MUNICIPAL ENGINEERING:

Sir—

Our attention has been arrested by a slip from your valuable journal in which you print eloquent comment upon England's slogan, "Business as Usual." In May of this year, when writing on this topic, we urged special support of "Unusual Business"—business that would conserve the resources of the nation at war—business that would produce food and clothing for the soldier and the citizen who supports the soldier—business that would prevent waste by converting the waste into useful products—business that should employ 100 per cent of available labor at wages that would insure the laborer a good living and something left to lend to the government in its need—business that would build dams to produce electric energy to turn the wheels of industry—business that should build railroads and keep them busy, construct docks and elevators, ships and canals, and substantial roads everywhere.

Present Importance of Permanent Roads

Of all forms of construction, none seems to us to be of greater importance in this national crisis than permanent roads and pavements. The building of roads represents an assembling of labor and materials in a structure which, when put to work, will serve the purposes of the nation in both its military and industrial activities for many years to come.

The demands of traffic and of sanitation make city pavements an imperative necessity. Improved roads in the country bring better educational advantages for the farmer boys and girls. Good roads and good schools are the two institutions on which we must largely depend for whatever success we have in perpetuating the principles of democracy upon which our forefathers founded the nation.

Good roads facilitate the transportation of products. The farmer uses his own road over which to reach his market, or rail, or water transportation, a hundred times to any one time of any other means of transportation. All his marketable products must pass on wagons or motor trucks over the highways. A permanent roadway permits him to haul double what he could over a poor road, thus enabling him to market a crop in one-half the time, or it places him one-half the distance nearer the market. Distance is now measured in time and not in miles.

President Wilson on Good Roads

President Wilson has said in one address: "It is perfectly obvious that you have got to have an intricate and perfect network of roads throughout the length and breadth of this great continent before you will have released the energies of America. Good roads are necessary for every practical aspect of our lives, to draw neighborhoods together, to create community feeling, to create those arteries which may be compared to the arteries of the human body."

On another occasion he said: "I should regret to see any instrumentality neglected which has proved serviceable in stimulating business and facilitating its processes. This is not only not the time to allow any slowing up of business, but is a time when every sensible process of stimulation should be used."

The Portland Cement Association has exercised its influ-

ence, through its many representatives in all parts of the country, in an effort to steady the situation, and it now appears that our efforts, added to yours and to those of many other earnest and patriotic business men, have brought to the country a more favorable business outlook, and we hope we have by this pull all together done our bit up to this time in the battle for democracy.

Very truly yours,

George A. Ricker,
Chicago, Ill. Highway Engineer.

Quincy, Ill., Concrete Pavement in Good Condition

The Editor of Municipal Engineering:

Sir—

The South Twelfth street concrete pavement in Quincy has been down for about three years, and has been subject to both heavy and light traffic. As yet it gives no sign of wear or cracking.

This stretch of paving is 1,412 ft. long and is 11 ft. wide on each side of a car track. It is a one-course pavement, 6 in. thick, of 2:4:6 mix. The paving between the street car rails is of brick, with a cement filler. The brick also extends 18 ins. outside the rails. The cost of the concrete pavement was about $6 per cu. yd.

The pavement has ½-in. expansion joints every 25 ft. It has held up exceedingly well.

Very truly yours,

G. L. Grieser,
Quincy, Ill. Assistant City Engineer.

Notes on Meter Settings and New Construction at Lansing Water Works

The Editor of Municipal Engineering:

Sir—

We are installing all residential meters in meter boxes at the curb line. We are using a Ford meter box of the "Wabash" type, 15-in. inside diameter for ⅝-in. meter setting and 18-in. inside diameter for larger meters. We make our own concrete tile and figure that an installation complete with ⅝-in. meter, meter box, tile, pipe fitting, and labor, costs us $11.50. We have installed approximately 2,500 of such installations per year for the past three years.

The results received have been very satisfactory, as this type of setting eliminates waste between the curb cock and the house, eliminates not-at-home reports from meter readers and the meters are not subject to tampering by the consumer.

Last winter our freeze-ups in meter boxes were less than one hundred. While a very small portion of our meters are located in cellars, we had almost an equal number of meters frozen in cellars.

It is just possible that a larger diameter tile for the ⅝-in. meter would eliminate nearly all possibility of freezing.

The writer has suggested to a number of meter men that they make a bottom connected meter for the meter box setting, which would greatly increase the distance between the riser pipes and the wall of the meter box, at which point we experience freezing in nearly every case.

One of the 3,500,000-gallon reinforced underground concrete reservoirs is practically completed, and the excavation is nearly completed for the second reservoir. These reservoirs were designed by Major Dabney H. Maury, consulting engineer, Chicago.

The improvements at the pumping station are as follows: The concrete work is practically all completed. The 10,000,000-gallon Snow engine is set up on its foundation. The 5,000,000-gallon Holly engine is on its foundation. The 3,000,000-gallon Alberger two-stage centrifugal motor-driven unit is ready for installation. The two 750-h.p. Sterling boilers are being erected. The 9x200-ft. Alphons Custodis Chimney Construction Co. radial brick stack is completed, and we expect to have the building enclosed within the next thirty days.

The new system being installed consists of large diameter deep wells, approximately 20-in. in diameter by 400-ft. deep, each well to be equipped with deep well pumps, likely of the multiple stage turbine type, which deliver water under low head to the two 3,500,000-gallon reservoirs. From there the water is taken by the high-duty pumping engine and distributed to the distribution system. Our present system consists of five pumping stations with electrical drive pumps, taking their water from the ground by suction, and delivering the same direct to the mains. With the rapid growth of the city, the recession of static head in the wells has made this plan of securing water inadequate for the needs of the city.

Our water works improvements now under construction will cost about $200,000.

Very truly yours,

Board of Water and Electric Light Commissioners.
Guy G. Crane, Manager.
Lansing, Mich., Nov. 2, 1917.

Plant Units and Lay Outs

Features of a Portable Air Compressor

Telephone, gas, water and sewer pipe layers find rock in many of their trenches. The accompanying illustration shows a telephone company using one of the No. 2 Schramm outfits drilling 4-ft. holes. It is not unusual for one man to drill as high as 125 ft. of holes per day. It is possible to drill with this outfit 10 times as fast as drilling by hand, and the compressor operating steadily all day will only use about 3 to 4 gals. of gasoline.

For air supply on larger jobs it is often very convenient to use a series of smaller units. Contractors, ditchers, excavators and others who have rock drilling to do, as well as structural iron workers, cannot always arrange their work so that one compressor unit will do all the work.

On most jobs the demand for air is comparatively light at the beginning. For this work one of the Schramm units can be used. This gives 24 ft. of air and weighs 1,200 lbs. This makes it an easy machine to get on and off the job and at the same time will handle all the ordinary tools, such as rock drills, riveters, etc. As the job progresses an additional outfit can be added. This makes the cost of doing the work lower than it would be if the machine were operating all the time. No engineer is needed. The machines are simple to start and need no further attention. The fuel expense is low, it is claimed.

A feature not to be overlooked is the question of weight. The three 24-ft. units weigh 3,600 lbs. The regular 80-ft. unit weighs close to 8,000 lbs. This means that in the first case no

horses are required to move about the 1,200-pound units. They can be set anywhere on the edge of the curb or close to a ditch or excavation. Either one, two or three can be operated, depending on the kind of pneumatic tools being used. If some part of the work away from the main job requires air, then one or more units can easily be put to work on that part.

USING PORTABLE AIR COMPRESSOR FOR DRILLING IN TRENCH BOTTOM.

The unit system of compressed air outfits is being used by structural steel workers, contractors, quarries, mine operators and others. They realize that all their jobs do not require a large, cumbersome machine. They also know that on every job, no mater how large, can be handled with the unit compressors. It is being done with concrete mixers, pumps, hoists and other equipments.

A Special Trailer for Pipe Hauling

A special trailer, of Warner manufacture, for pipe hauling is here illustrated. These trailers are now built in two capacities, Model D-10, 3,500 lbs. capacity; Model D-20, 5,500 lbs. capacity. These capacities are rated for the trailer itself. A 3-ton truck in conjunction with the Model D-10 will handle a

A TRAILER FOR HAULING PIPE.

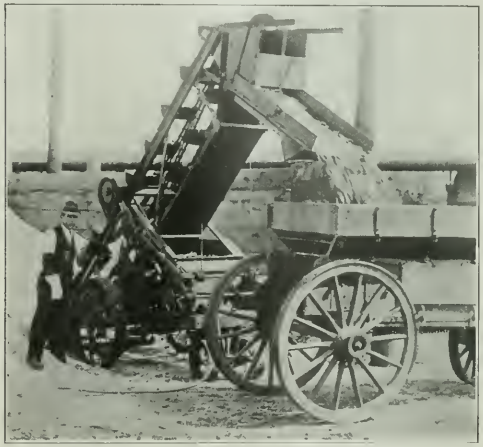
5-ton load, the trailer practically operating only the overhang of the load.

The manufacturers have shipped better than 100 of these trailers into the oil fields of Oklahoma within the last two months. They are principally used for hauling oil casing in 25 to 30 ft. lengths and are also used for hauling miscellaneous other material. They have been successful and are built so they will stand the hard abuse they will receive in that line of work.

A Self-Feeding Bucket Loader

The particular features embodied in the Barber-Greene loader are: Large capacity for handling heavy materials in quantities; minimum labor in operation; easy removal from one position to another. It is self-propelled and has two speeds. One operator handles it. It handles a cubic yard per minute and has a 5-ft. digging width. It is suitable for handling crushed stone, sand, gravel, coal, etc.

It is the only machine of its type, it is claimed, which has been developed for handling heavy, loose materials in quantities and which can handle a large capacity without requiring a gang of laborers to feed the buckets. The rotating discs at the base elevator give an effective digging width of 5 ft.,



SELF-FEEDING BUCKET LOADER IN OPERATION.

which otherwise would be no greater than the width of the buckets themselves. A further advantage of these discs is that the buckets are able to dig off of a smooth surface rather than out of the pile and consequently the power consumed by the discs themselves is made up by the better digging action of the buckets.

The general construction of the machine is arranged to get the necessary advantages from the disc feeder. It is provided with forward and reverse speeds which provide the best operating conditions on the job and also with speeds suitable for moving from one job to another as required.

Gun Mounted on Corduroy Traction a Feature of Milwaukee Liberty Loan Parade

The accompanying illustration shows a "42-centimeter gun" mounted on Pawling & Harnischfeger Co. corduroy traction as it appeared in the Milwaukee Liberty Loan parade. The gun was hauled on a 3½-ton Stegeman truck. The P. & H. Engineering Department designed the gun and the pattern shop handled the wood work. The traffic department contributed the truck and the excavation department contributed the corduroy (caterpillars) and broad-face wheels.

This picture at once suggests the practicability of the P. & H. corduroy traction for heavy guns for service in France. It is believed that the cannon here shown is the first cannon mounted on corduroy traction built in America.

The corduroys used in this machine were a pair of standard corduroy tractions, 20-in. face and 5-ft. 6-in. between the center lines of the end sprocket shafts. This size corduroy is regularly used on the P. & H. 8½-ton pipe line excavator and has a carrying capacity of about 1,000 pounds to the square foot.

Here are the specifications for this corduroy grip traction (as written for the corduroy traction P. & H. ditcher):

"Corduroy Grip" tractions are provided for supporting the rear, or heavy end of the machine. These tractions are each 20 ins. wide and 5 ft. between the center lines of the end sprocket shafts. They are driven by means of chains through a differential on the main propelling shaft. The main frames of the tractions are built up of structural material and are

HEAVY GUN MOUNTED ON CORDUROY GRIP TRACTION.

pivoted on a heavy shaft supported in bearings on the under side of the car body. This enables the tractions to accommodate themselves independently to inequalities in the ground and relieves the main frame work supporting the machinery of all twisting strains. The traction chains are made up of steel casting links with manganese steel bushings and pins, insuring long life to the parts. The supporting blocks are of hard wood fitted on their upper surface into sections of steel channel and shod on their lower or bearing surface with steel plates. The pressure between the supporting blocks and supporting frame is taken by a series of chilled iron rollers of large diameter. The general design of the tractions is such that they can easily be dismantled for repairs.

A New Gasoline Rock Drill

The Scott gasoline rock drill has been developing for a number of years and in its present form is here illustrated.

This machine is a complete self-contained rock drilling plant, mounted on a tripod and eliminating the power plant and pipe lines required by other drills. Although these drills have been operated in the St. Louis quarries for the past five years, the maker did not feel fully satisfied to put his drill on the market until now. A Scott drill operating at the Glencoe Lime and Cement Company, St. Louis, Mo., has drilled 68 ft. in a 9-hour day, using 2 gals. of gasoline and ¼ pint of cylinder oil. The rock was hard limestone.

The size of machine developed will drill holes up to 12 ft. in depth, weighs 200 lbs. without the mounting, and all parts are enclosed and protected. Gasoline is supplied from a small steel pressure tank—a pressure of 2 lbs. is pumped up by hand twice per day—about one minute required for pumping up pressure.

The drill operates on the "hammer" principle. A hollow hexagon drill steel is used (no special shank is required) and the water for cooling the engine is run through the hollow steel to the bottom of the drill hole. About 800 blows per minute are struck. The engine is a simple single cylinder two-cycle and is free from valves, gears and cams. The hammer is moved directly by explosive pressure and strikes a "free piston" blow. There are two pistons, one contained within the other. The outside piston is the hammer and has no mechanical connection with the inside piston, which latter is connected to the crank shaft through connecting rods. An explosion takes place with every down stroke, driving the two pistons downward. The hammer piston strikes its blow on a tappet (which contacts with the end of the drill steel) at about 60 degrees before the crank shaft has reached its lower dead center. The inside piston moves on (independent of the hammer piston) with the crank shaft. The inner piston uncovers

THE SCOTT GASOLINE DRIVEN ROCK DRILL.

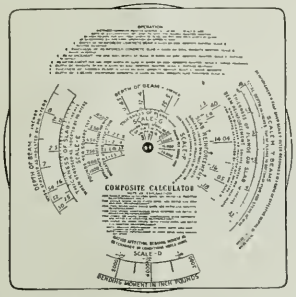
air ports in the hammer piston (on its independent downward movement) and on the back stroke (caused by the momentum of the flywheels) the hammer is picked up on a cushion of air. When the hammer strikes its blow it is free and disconnected from all parts. It will be seen by this arrangement that no shock to the crank shaft or bearings is possible. Ball and roller bearings are used on the crank shaft and rotation shaft. The drill steel is rotated step by step by a special "compound" gear, no ratchets being used to get intermittent rotation.

A Composite Calculator for Engineers

The composite calculator here illustrated is a handy calculator for designing reinforced concrete slabs, beams and girders of every description and for various kinds of wood. For designing the following results can be obtained: Size of reinforced concrete plain beams; size of reinforced concrete tee beams, thickness of reinforced concrete slabs, reinforcement for plain and tee shaped concrete beams; size of various kinds of wooden beams, and thickness of various kinds of wooden planks and boards.

It is equally useful for: Checking the safe load that any beam or slab of known size and span will carry; for comparing the relative size of plain and tee concrete beams with

no change of the disk's setting, thereby giving the proper section of beam both at the center of the span and at the haunches where the relative position of tension and compression are reversed; for taking into effect the action of built-in beams of one span as well as the continuous action of several spans; for directly comparing the relative size of concrete shapes with those of various kinds of wood, and for multiplying and dividing as on the ordinary slide rule with the additional advantage that the result is pointed off. All computations for concrete are based upon the joint committee recommendations, using the Straight Line Formula. The composite calculator was recently placed on the market by Kolesch & Co., of New York City.

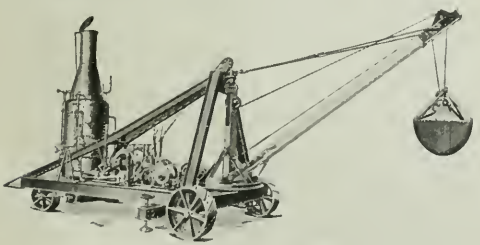


A COMPOSITE CALCULATOR.

Traveling Transfer Machine Useful on Construction Work

When equipped with a clamshell the Clyde traveling transfer machine here illustrated will load or unload cars or trucks or handle to and from bins and stockpiles stone and sand. With clamshell removed, the machine becomes a traveling crane or can be used for driving piles. Two men, one engineer and one laborer, operate the machine.

The machine is mounted upon cast semi-steel wheels and is self-propelling at a speed of 2½ miles an hour, enabling it to be moved to any point for loading or unloading; or to avoid blasting work.



TRAVELING TRANSFER PLANT UNIT.

The front wheels are the driving wheels, and rear wheels the steering wheels. The steering is controlled by a hand wheel on the deck next to the boiler. The propelling is accomplished by a chain and sprockets from the engine shaft through an intermediate shaft to the front axle. The engine is 6¼x8 in., double cylinder, double drum, 20-h.p., mounted on the car frame. It has a load capacity of 4,500 lbs. on a small line.

On the front end of the car is mounted a rectangular frame of structural steel efficiently braced to support the mast top. The mast top is of 8x8 in. timber; the bull-wheel is 4 ft. in diameter. The boom is 20 ft. long, fitted with clamshell boom end. The complete machine is given stability by outriggers extending from the top of rectangular frame and ending in a suitable bearing shoe.

Special Road Roller with Scarifier Attachment.

A special road roller with a scarifier attachment is here shown tearing up a bituminous macadam. This Buffalo Pitts roller will also tear up concrete pavements and bases. They have great flexibility of operation as they can also be used for light surface loosening and for the removal of sheet asphalt and sand oil carpets for the application of new coats. Contractors have had good satisfaction from their use of this machine. Henry P. Burgard Co., General Contractors, Buffalo, N. Y., tried one of these machines in the fall of 1915 in tearing up sheet asphalt, tearing up concrete base under old sheet asphalt pavement and in tearing up macadam. They speak highly of the service rendered by the machine. The German Rock Asphalt & Cement Co., of Buffalo, report that this machine does work in a day in ripping up concrete base that would cost $150 by other methods.

STANDARD ROAD ROLLER WITH SCARIFIER ATTACHMENT.

The loosening device is reversible as well as the roller. The teeth are adjustable for depth and angle of penetration. Hand wheels govern the depth of penetration. For light work full sets of short teeth are usually employed, while for heavy excavating a lesser number of longer teeth are used. The latter are self-sharpening. The scarifier attachment does not in any way impair the usefulness of this standard roller.

Plant Units Used on Construction of Camp Devens, Ayer, Mass.

On the construction of the National army cantonment at Camp Devens, Ayer, Mass., the following plant units were used by Fred T. Ley & Co., Inc., Springfield, Mass., the general contractors: 19 concrete mixers, including ½ bag Ran-

some Bantams and 1 bag Standard mixers; 5 trenching machines, of which two were Pawling & Harnischfeger, 2 Buckeye and 1 Parsons, respectively; 1 P. & H. backfiller; about 100 motor trucks, ranging from 750 lbs. to 5 tons capacity, and including 6 Duplex 4-wheel drive, 4 Smith Forma-Trucks, Mack, Saurer, Pierce-Arrow, Peerless, etc.; 3 steam shovels, consisting of a ⅝-yd. Manon, ¾ yd. Osgood and a ⅞-yd. Bucyrus; 2 10-ton Buffalo road rollers, about 50 dump wagons of all makes, 1 7x10 D. D. Lidgerwood hoisting engine, 1 78-ft. mast, 76-ft. boom Terry & Tench derrick, 1 1-cu. yd. Haiss clamshell bucket, 20 portable saws, including 6 S. A. Woods Co. railway cut-off, and 4 automatic feed of Woods manufacture, 2 Elliot saw rigs, 6 American portables with Novo engines and 2 A. E. Kidder No. 2; 2 Studebaker sprinklers, 10 Novo trench pumps and 2 Keystone excavators. Each piece of plant sent to the job was appraised and the government reserved the privilege to buy it from the contractors.

The Uni-Form System of Floor and Roof Construction

The Uni-Form system of floor and roof construction in reinforced concrete has for its distinguishing feature a system of removable steel forms composed of channels combined with arch plates or pans, and coupled by spreaders. When poured and stripped there is left a monolith floor consisting of joists and arched connecting slabs. The system requires support only on 10 ft. centers, instead of thick shoeing necessary in the ordinary beam and girder or flat slab construction. The steel forms are stiff, strong and permanent in shape and are stripped from the concrete on each job to be used over again indefinitely. They are a part of the concrete contractor's plant.

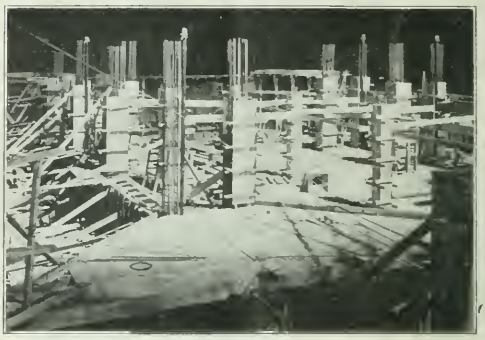
The system consists primarily of steel channels, concave side up, into which are clamped a series of inverted pans stuck up in dies from 14-gage steel. Through punched holes

GENERAL ARRANGEMENT OF THE UNI-FORM SYSTEM

in the channel web ⅜-in. stock machine bolts are slipped and these engage similar holes in the spreader. The spreader forces the pan hard against the channel flange, thus binding the whole system rigidly together and preventing leakage of cement. The forms are so rigid that loaded concrete cars or wheelbarrows can be run over them without danger or distortion. The wood shoeing used in the Uni-Form system is also salvaged until worn out by repeated usage. This system makes possible the saving of 40 per cent. of the concrete in flat slab construction of the same strength. Carpenter work is required on the girder forms; aside from that the system is practically erected by common labor.

Flood Lamps Facilitate Night Construction Operations

The accompanying view shows the Edgewater Beach Hotel, Chicago, under night construction. This night work was made economically feasible by the use of Western Electric Davis Flood Lamps. Two of the units were mounted on top of the concrete hoisting tower, 185 ft. above the ground, and turned on the work below. They gave practically daylight efficiency. The light from these lamps is diffused rather than in beams



LIGHTING NIGHT CONSTRUCTION FROM TOP OF CONCRETE HOISTING TOWER.

centering on particular spots. For outside work they are usually mounted on tops of buildings or poles, where they give best distribution over a maximum area. For interior use they are mounted close to the ceiling. A steady lighting effect is secured. The lamps operate either on direct or alternating current. In addition to their use on construction these lamps are used for lighting factory yards, railroad yards, etc. They use a 750 or 1,000 watt standard Sunbeam Mazda lamp.

Snow Removal Methods and Equipment

Where can I obtain the latest information regarding snow removal methods and equipment? This is a community of some 1,500 people and it has concrete roads and sidewalks. We have been using horse-drawn snow plows to open up channeds of traffic, but it occurred to me that some more practical and inexpensive method may have been developed. Can you refer me to any articles in recent publications along this line?

D., Manager, ———, Minn.

The latest on this subject will be found in MUNICIPAL ENGINEERING. The street cleaning departments have found by experience, much of the development having been made within the past three years, that the easiest and most economical way of opening up lines of travel is to begin promptly when the snow begins to fall and keep up the work until the streets and sidewalks are all clear. By following this plan the exertion required is not so great and melting or packing of snow under traffic does not render removal difficult or impossible. Plows, scrapers and brooms are the principal weapons used, horse or auto-driven according to taste or facilities. In MUNICIPAL ENGINEERING for February, 1916, are two articles, one on "Systematic Snow Removal in New York" and one on an "Auto Truck Snow Plow," and in June, 1916, one on "Prompt Snow Removal in Philadelphia, and in November, 1916, one on "Removal of Snow in Parks, Problems and Methods," all illustrated, which give the latest experience and advice of the foremost experts on this subject.

DIGEST OF THE ESSENTIAL NEWS

Highway Motor Truck Freight Trains Now Running Between Akron, Ohio, and Boston, Mass.

Highway freight trains are now running in the United States—running over country roads, from Akron, Ohio, to Boston, Mass., and return, covering a distance of 1,510 miles in a week.

Thus, what all the good roads propaganda for the past 15 years has failed to achieve, the freight car shortage and a national crisis have accomplished. The public has been forced to make greater use of its greatest transportation asset—the country road.

The truck line from Akron to Boston is being operated by the Goodyear Tire and Rubber Company. It is called the "Akron & Boston Express." The present equipment consists of two Packard and two other trucks, of 1½, 3 and 5-ton capacity. It is planned to increase the equipment, and, according to J. L. Sydnor, the company's efficiency specialist, additional trucks are already ordered.

VIEW OF ONE OF THE MOTOR TRUCK FREIGHTING UNITS OPERATING BETWEEN AKRON, O., AND BOSTON, MASS.

A regular schedule is maintained. M. D. Scott, manager of garage, says they are usually on time. The schedule calls for the round trip (1,510 miles) in less than one week. Mr. Sydnor says that the express companies do not deliver stuff as rapidly as that, and that the truck costs are competing with express rates. Tires are loaded for their Eastern branches and cotton fabrics and machinery for their plant in Akron is carried on the return trip. Several trips have been made to Washington, D. C., with "war orders" and good time was made.

Messrs. F. A. Seiberling, president, and P. W. Litchfield, factory manager, are the instigators of the movement. Service was started last April and Mr. Sydnor hopes to continue through the winter unless stopped by too much ice and snow. There is only 28 miles of unimproved road, which bothers considerably in muddy weather. The poor condition of some of the old wooden and steel bridges is another handicap. Pneumatic tires are used exclusively, at a greater cost per tire mile, says Mr. Sydnor, but with less wear and tear on trucks and roads.

The country road is at last coming into view as "the railroad of tomorrow."

Detroit Has $8,250,000 Available for Sewer Construction

Within the last two years the city limits have been extended in such a manner as to about double the area of the City of Detroit. Portions of this area are already built up and are without proper sewerage facilities.

On July 1 a bond issue of about $8,250,000 became available for the construction of approximately 31 miles of trunk sewers, the intention being to provide for a 2-year program. Bids were recently received for two sections of sewer ranging in size from 5 ft. to 14 ft. in diameter, covering a length of approximately 5 miles. However, due to war conditions bids received were so far in excess of the money available that no contracts have as yet been let, writes Clarence W. Hubbell, city engineer. It is expected to re-advertise a portion of this work and one or two other sections in the near future, in the hope that better prices can be obtained.

The trunk lines outlined form a portion of a system which will eventually include three treatment works, as treatment works will be necessary in order to comply with the treaty requirements between the United States and Great Britain in regard to the pollution of boundary waters. Treatment works, however, have not yet been authorized by the city, except for the purchase of one of the sites.

In addition to the trunk lines, petitions are filed for perhaps 100 miles of lateral sewers, in addition to the 50 miles which we hope to complete before the close of the season. Contracts for lateral sewers are being let approximately every two weeks, 10 to 12 jobs being advertised each time. Lateral sewers are paid for by lateral sewer bonds or the proceeds therefrom, and the cost of the lateral sewer is assessed against the abutting property.

New York City Merchants Will Co-operate with Street Cleaning Department in Snow Removal

Street Cleaning Commissioner Featherston has informed the committee of the Merchants' Association of the City of New York that the difficulties hitherto encountered by his department in obtaining sufficient labor for prompt removal of snow will be greatly increased during the coming season by the scarcity of the labor supply. He is of the opinion, therefore, that unless effective plans for cooperation by merchants, truckmen and railroads to give aid in snow removal can be arranged, extremely serious and protracted interruption of street traffic may occur during the coming winter.

Details of the Plan.

The committee, in conference with the Street Cleaning Commissioner and the Motor Truck Club of America, has considered a plan for the purpose named. It is proposed that immediately following a heavy snowfall, merchants agree to suspend a certain designated class of outward bound shipments during say, one-half of the day for a period, if necessary, of two or three days; that during such time of suspension they release their trucking contractors from the obligation of moving freight and thereby permit such trucking contractors to place their trucks at the disposal of the Street Cleaning Department; that merchants and shippers whose packers and porters cannot be fully employed while the movement of

freight is suspended assign such packers and shippers as can be spared to the duty of loading snow from the streets in the immediate vicinity of such merchant's premises upon the trucks so released.

Under this plan several hundred trucks or more, together with the necessary help for loading, can be at once employed in the removal of snow from business streets designated by the Commissioner, whereas several days would necessarily elapse before all of the streets in question could be freed from snow if only the force of the department were employed.

Cook County (Ill.) Votes $1,000,000 Road Bonds

The $1,000,000 county road bond issue carried at the judicial election held on Nov. 6 in Chicago and Cook County.

The need of a bond issue was suggested primarily by the much discussed plan for a military road from Chicago past Ft. Sheridan and the Great Lakes Naval Training Station to the Wisconsin state line. A little more than half the cost of paving this highway was offered by the state and federal governments on condition that Lake and Cook Counties do the rest. Lake County has also voted its share of road bonds to defray the cost of this highway work.

Roads to Be Improved.

In addition to this route these highways have been surveyed and provided with permanent pravements:

One Hundred and Forty-seventh street, from Forty-eighth avenue to the Village of Orland, thence to Tinley Park.

A road through Homewood, Thornton and Lansing, to connect with the Lake County, Indiana, system of main highways.

Three miles of Lake street to the county line, and the extension of Irving Park boulevard to the county line.

Other Improvements Planned.

Other roads which the county authorities want to pave, and which were included in the bond issue plan, are the unimproved portions of Archer avenue, on the projected Chicago, Springfield and St. Louis highway; the Desplaines River road, through the recently acquired forest preserves, from Twelfth street to Milwaukee avenue; the Lincoln highway, from Chicago Heights east to the state line and west from the present construction to the county line, and about 10 miles of road through Glenwood, Thornton and Riverdale, to provide an additional southern entrance to the city.

Altogether, something like 80 miles of new pavements is contemplated—all on main traveled routes.

Present Status of Road Work in Massachusetts

As has been the case in all public works during 1917, the high cost of labor and material, together with the difficulties of securing material by rail on account of embargoes and scarcity of railroad equipment, has caused much greater expense in construction and maintenance work and also much delay in carrying on work, with the consequent inconvenience to the traveling public. We have, however, succeeded in completing a large number of contracts and in keeping our state highways in good condition for travel, writes Arthur W. Dean, Chief Engineer, Massachusetts Highway Commission.

During the latter part of the year we have confronted not only high prices in labor, but a great scarcity of labor owing to the drain made upon the labor market by the construction of the cantonment in this state.

As in previous years, we have built several different types of road surfaces, being governed by the amount of traffic to be carrried and the availability of building material. The prevailing surfaces which we have constructed, however, have been bituminous macadam, bituminous concrete and cement concrete.

The present outlook for 1918 is not encouraging, but should conditions be no worse than they have been during the present year, it is probable that we shall continue constructing about the same amount as during 1917, and shall, of course, carry on maintenance and necessary reconstruction of state highways.

Should conditions grow worse, it may be necessary to limit activities to maintenance alone.

The state expenditures during the year 1917 will amount to approximately $4,000,000, and it is anticipated that approximately the same amount will be available for use in 1918.

Kansas All Set for Brick and Concrete Road Construction

Practically all of the Kansas road and bridge laws were revised and modified by the legislature last winter and the townships and counties have been busily getting organized under the new law, writes W. S. Gearhart, state highway engineer.

Practically all of the county engineers have now been appointed and approved by the Commission. Most of the counties have selected their county road systems and these systems will be approved by the state highway engineer very soon.

Kansas appropriates no money for road building on account of the constitutional provision and all of the funds for road and bridge construction are provided from the local communities. Most of the surfaced road work will be financed by the Benefit District plan and a great deal of the road work which is being petitioned for at the present time will be under contract so the work can be started next spring. Not a great deal of surfaced road work has been done this year. Most of the work now being petitioned for will be brick or concrete.

Road Work in Albama in 1917 andPlans for 1918.

By W. S. Keller, State Highway Engineer, Montgomery, Ala.

The Alabama Highway Commission is working under a law passed by the Legislature in 1911. At that time demonstration work was badly needed in nearly every county in the state. The law was so framed as to give every county, regardless of area, population, or road mileage, an equal amount of money annually. The amount appropriated was $2,000 annually to each county, which would be available for a period of two years. Any county failing to take the appropriation within the two years period would lose it and it would be redistributed among the 67 counties of the state. Illustrating this, the appropriation to the counties for the current year is $2,439.52, of which $439.52 is 1-67th part of unused funds for the year 1915.

Demonstration work has long since ceased to be necessary and the law, consequently, is to some extent out of date. The Legislature of 1915 passed what is known as the "State Trunk Road Law." This law designates certain roads in the state as State Trunk roads and makes it unlawful to use state funds on other than such roads unless all state trunk roads in a county have been constructed to the satisfaction of the State Highway Commission. In such cases the money may be used on any other main traveled highway.

The Trunk Road System.

The trunk road system embraces approximately 3,000 miles, of which about 1,500 is now in good condition. Less state aid construction work has been done during the present year than than for a like period for several years. The main reason is the counties anticipating the federal appropriation have preferred to allow the state funds due them to accumulate in order that they might use such with their own funds to secure such allotment of this federal fund as the State Highway Commission might give them.

There not being sufficient state appropriation to meet the

federal appropriation, it is necessary for the State Highway Commission to ask the counties to meet the allotment with their own funds, to a very great extent.

We have spent during the present year on roads finished and still under construction, including county funds used with state funds, a little over $100,000. The roads constructed have been mostly gravel and sand clay. A few miles of chert and macadam roads have been finished, and a few counties have used their state aid in building concrete bridges.

Approved Projects.

Alabama's allotment of federal aid of the fiscal year, 1917-1918, is $312,446.70. The State Highway Commission has submitted statements for 29 projects, of which 18 so far have been approved. A summary of those approved, showing estimated cost and milage, is as follows:

84.81	miles sand clay road	$221,350.42
36.65	miles gravel road	122,119.37
5.5	miles chert road	22,834.35
2.5	miles bituminous macadam road	21,564.10

Most of this work will be under way by January 1. Priority Order No. 2, issued by Judge Lovett, will delay the construction of about half of the gravel work and the macadam.

In addition to this work a number of counties will take state aid alone for the construction of small sections of their trunk roads yet in bad condition. Including the federal appropriation for the fiscal year 1919, available July 1, 1918, and a like sum to meet it, with the present appropriations, over $1,000,000 worth of work should be finished and under way by the close of 1918.

Engineer Proposes Concrete Mains to Carry Natural Gas

Concrete will aid materially in relieving the pipe shortage and bring natural gas to New Orleans at an early date, in the opinion of Howard Egleston, a New Orleans civil engineer. Under present conditions, Mr. Egleston believes it is not only a wise but a patriotic duty to make a thorough test of the use of concrete gas mains, and he quotes others to sustain his views.

The test of concrete gas mains, Mr. Egleston says, can be made at no great cost and with the loss of but little time. If the test is successful, and he has no doubt that it will be, a concrete gas main can be constructed from the Terrebonne field to New Orleans within a year.

Mr. Egleston's plan is to construct two large concrete gas mains from the Terrebonne district to the city. Two large mains, he says, will not only furnish an abundant supply of gas, but will safeguard the city against accident. If one of the mains should be out of order the other would furnish a supply of gas until the damage could be repaired.

Scheme in Operation.

Calculation shows, says Mr. Egleston, that with a pipe 36 in. in diameter and 10 miles long, 50,000,000 cu. ft. of gas can be delivered, using a pressure of only 10 pounds. I therefore, propose to drive the gas through the first 10 miles of the pipe line by means of the "rock" or natural pressure, then "boost" it along another 10 miles by using a turbine blower or compressor, and so repeat through the length of the pipe line till the city is reached. To deliver 100,000,000 cu. ft. of gas per day it will be necesary to lay two lines of pipe, which will be highly desirable, for accident to pipe or machinery of one line would not cut off the city's supply.

Making concrete pipe that will stand an internal pressure of 10 lbs. is a matter of daily manufacturing practice. Any well made machine-made pipe will stand a much higher pressure, and can be, and often is, made so that it will safely stand pressures of 40 lbs. and more. In our case it would probably be a matter of extra safety and wisdom to use some slight reinforcement.

Preventing Leaks.

The matter of making pipe gas tight was more serious, for a pipe that will stand a heavier internal pressure of water may leak gas at a very low pressure, but after corresponding with a number of the largest and oldest manufacturers of waterproofing materials, some of whose names were supplied me by the director of the United States Bureau of Mines, I have the assurance from many of them that they will guarantee that the pipe can be made absolutely air and gas tight. Which process will prove to be the best remains to be demonstrated by tests.

Using Dynamite in Excavating Creek Gravel

By J. U. Bradley

There is a plentiful supply of excellent gravel for making concrete and for road surfacing purposes in a creek bottom near Hazelwood, Indiana. The creek is about 100 ft. wide, and the best gravel is obtained from the creek bed where the flowing water has washed out the foreign material and sediment, leaving the gravel clean and free from dirt.

Since the excavation must all be done under water, a good heavy drag chain with buckets attached is dragged across the bottom, bringing the gravel up and dumping it. It was found that at a depth of about 6 ft. there was a layer of hardpan in which the buckets would jam, and stop operations for some time until they could be loosened. This hardpan was about 18 ins. thick, and was underlain by good gravel, but as the buckets would not penetrate it, only the gravel above the hardpan was used.

Though not in charge of the work, I suggested that I be allowed to try the effects of dynamite for loosening the chain and buckets after they had become jammed in the hardpan about 6 ft. under water. Accordingly, I obtained some Red Cross Dynamite and made up several one-cartridge primers with a cap, and about a foot of fuse for each cartridge. These were lighted and dropped into the water at 10-ft. intervals along the chain, while at the two ends, where the hardpan seemed to be the strongest, two cartridges tied together were used.

The machinery was they started up, and the chain was found to be free, the buckets coming up full. The blasting had not only loosened the chain and buckets, but had broken up the hardpan and loosened the gravel, so that every bucket worked to capacity. During a timed four-hour run immediately after the blasting, 40 cu. yds. mors of gravel were excavated than had ever been done in a samilar period before. This showed conclusively that the job could be handled more economically by using explosives, and that the underlying gravel status could be rendered available for use.

Road Work in New Hampshire

Plans for highway work in New Hampshire for 1918 have not as yet been made. "While we have had an appropriation for two years, 1917-1918, for new construction larger than for the two previous years," writes Frederic E. Everett, Commissioner of the New Hampshire Highway Department, "we have been able to accomplish but very little work owing to the scarcity of labor and the impossibility of getting road material.

"Up to the time most of our trap rock for road work has been shipped in from Massachusetts. Owing to embargoes we have been unable to get shipments this year and therefore we have not accomplished anywhere near the amount of work we had laid out. State aid construction is going on, but this work started at least six weeks later than usual and none of it will be completed.

Advance Information on Big Jobs

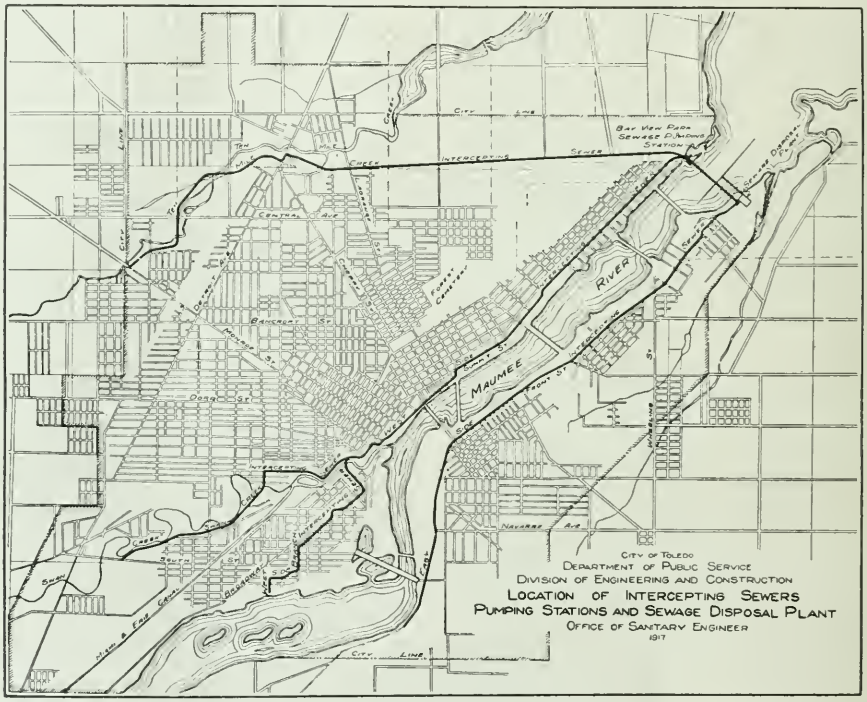
Toledo Votes $2,800,000 for Sewage Collection and Disposal

The sewage collection and disposal bond issue carried by a large majority at the election held on Nov. 6, 1917, in the City of Toledo. H. C. McClure, commissioner of engineering and construction, writes that his department will be in a position to push the work according to the prearranged program.

The bond issue of $2,800,000 was approved and portions of this authorized issue will be voted from time to time by the council to take care of the necessary parts of the complete plan. The entire plan calls for some 20 miles of sewers, ranging in size from 48 in. up to perhaps 84 in., numerous interceptors with combined sewers, several siphons, two pumping plants and a complete disposal plant.

It is planned to ask council to authorize $700,000 of this total issue at once in order to take care of what is known as the Ten Mile Creek Interceptor and Bay View Park Pumping Plant. This interceptor will be approximately 6 miles in length, 48 in. to 72 in. in size, several interceptors and two siphons. About half of the length will be in open-cut and the balance will be entirely in tunnel.

The pumping plant building will be of such size that ultimately it will have a capacity of at least fifty million gallons per day. The building will be built in a park district and will be a handsome, substantial structure. Motor-driven centrifugal pumps will be installed to take care of about fifteen million gallons at this time.



MAP SHOWING ESSENTIAL FEATURES OF PROPOSED SEWAGE COLLECTION AND DISPOSAL SYSTEM, TOLEDO, O.

PROPOSED BAY VIEW PARK PUMPING PLANT, TOLEDO SEWERAGE SYSTEM.

The bond legislation will take at least 60 days so that this Ten Mile Creek Interceptor and Bay View Park Pumping Plant will not come up for actual figures until about February 1st. "At that time we would be very glad to get in touch with responsible contractors who are capable of handling jobs of this magnitude," says Mr. McClure.

Engineers Recommend $3,000,000 Sewage Treatment Plant for Indianapolis

A report on the sewage disposal situation in Indianapolis was recently submitted to the Board of Sanitary Commissioners by George W. Fuller, of Fuller & McClintock, Consulting Engineers, 170 Broadway, New York.

Projects Considered.

Detailed study was given to three projects for the treatment of the sewage in plants of a size sufficient to deal with the flow of 1925, as follows:

Project 1. Sedimentation in Imhoff tanks with the sludge put on drying beds so as to allow it to be used by farmers in the vicinity, or for filling low land, and with settled sewage oxidized to a non-putrescible state in sprinkling filters and settled in humus tanks, frequently spoken of as final settling tanks.

Project 2. Aeration of the sewage in contact with activated sludge, followed by sedimentation and with the deposited sludge filter-pressed and dried in rotary dryers in order to put it into condition for sale to the fertilizer trade.

Project 3. Fine screens to remove the coarser suspended solids, with the screened sewage applied to deep sprinkling filters for purposes of oxidation, and with the effluent thereof put through humus tanks, the sludge from which will be filter-pressed and dried for sale to the fertilizer trade.

The Project Recommended.

After due consideration of all local factors, we recommend, reads the report, without qualification, the adoption at the Sellers Farm site of Project 3, consisting of fine screens, deep sprinkling filters, humus tanks and sludge-drying arrangements to allow the sludge to be sold to the fertilizer trade. This project represents an investment estimated at $3,090,050, with net operating expenses reduced by the sale of sludge to $42,372.

We understand that this investment cost is in excess of available funds, and in view of these circumstances we formally recommend that the intercepting sewer, grit chambers, pumping station and fine screen plant be installed of full capacity, and that the filters, tanks and sludge-treatment arrangements be built of about two-thirds of the capacity for 1925 conditions. This would make an investment cost of $2,438,000, with net operating expenses of $50,370, the return from sales of sludge being necessarily less than for the unmodified project.

Modifications Suggested.

This modified project, called 3-A, would provide for the elimination of the gross sewage solids continuously throughout the year and for short periods of exceedingly warm weather and low stream flow would treat enough sewage to prevent objectionable putrefactive conditions in the lower White River. Certainly the corrective treatment will afford a substantial remedy, and as additional funds become available, additional units may be installed to meet the needs of the increased sewage flow up to conditions of 1925 and thereafter.

Projects 1 and 2 might also be built at first with only a part of the units needed for 1925 conditions, with additional units added as construction funds become available. But if treating only two-thirds of the dry-weather flow of 1925, Projects 1A and 2A become impracticable on account of their annual net operating expenses becoming $73,690 and $64,950 respectively, as compared with $50,370 for Project 3A. The latter sum is negotiable under the existing Act, but neither of the other two sums is.

Taking everything into account, we are firmly of the opinion that Project 3, modified in capacity to such extent as financial necessity demands, is the wisest and best method to adopt for treating the sewage of the Indianapolis Sanitary District.

Statement by Sanitary Commissioners.

The Commission made the following statement concerning the report:

"The Board of Sanitary Commissioners will take further time to study the report of Mr. Fuller. Consideration will be given to Projects 1 and 3, the board agreeing with Mr. Fuller that Project 2 is not applicable to local conditions. The board wishes to investigate more fully the feasibility of pressing and drying the sludge for fertilizer on a large scale and the market for such commercial fertilizers, the expense of operating a sludge pressing and drying plant, and the reliability of mechanically operated screens.

"The estimates of the three projects, as made by Mr. Fuller, were based on the prevailing high prices, and with a tendency toward reduction in prices of building materials, which has occurred within the last few days, especially cast iron and steel, the board feels that it will be able to construct an entire plant under Project 1 or 2 within the amount of money which will be available for constructing a sewage disposal plant.

"Indianapolis is fortunate in that a large gravel bed underlies the site for the sewage disposal plant in Sellers' farm, and that since the structures required for a sewage disposal plant are composed almost entirely of concrete a great part of the material required is already at the site.

Plans Now Well Under Way.

"Although the commission has not decided on the final method of treatment for sewage best adapted to local conditions, plans for the necessary interceptor and the pumping station which will be required in all three projects are now well under way.

"The board has had an appraisal made of the present garbage disposal plant and estimates of the changes required to better the sanitary conditions. Before the end of the year steps will be taken to acquire this plant or to construct a new garbage reduction plant in conjunction with the sewage disposal plant."

The Board of Sanitary Commissioners consists of B. J. T. Jeup, City Engineer, president; Charles H. Hurd, Consulting Engineer, Indianapolis, vice-president, and Jay A. Craven, secretary. The Commission plans to go ahead with the work and has retained two engineers on their staff, W. H. Durbin, of Evansville, Ind., and A. G. Husted, Cleveland, O. Mr. Fuller was assisted in preparing the report by Paul H. Norcross, Atlanta, Ga.; by James R. McClintock and Jesse K. Giesey, of Fuller & McClintock.

COMING CONVENTIONS

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS—Annual meeting at Hotel Jefferson, Richmond, Va., Dec. 4-6. Acting Sec'y, H. M. Berry, Chapel Hill, N. C.

NEW JERSEY STATE LEAGUE OF MUNICIPALITIES—Annual convention at Trenton, Jan. 3-4. Sec'y. Clinton A. Swartz, Trenton.

VIRGINIA GOOD ROADS ASSOCIATION—Annual convention at Richmond, Jan. 15-17, 1918. Sec'y, C. B. Scott, Richmond.

AMERICAN CONCRETE INSTITUTE—Annual meeting at Chicago, Feb. 7-9. Sec'y, Harold D. Hynds, 27 School St., Boston, Mass.

CONTRACTORS AND BUILDERS SHOW—Supersedes annual Chicago Cement Show. To be held under auspices of the National Exhibition Co., 123 West Madison St., at the Coliseum, Feb. 6-13, 1918.

IOWA ENGINEERING SOCIETY—Annual meeting at Waterloo, Feb. 20-21. Sec'y, J. H. Dunlap, Iowa City, Ia.

How the Contractors are Bidding

Bids on Road Construction in Pennsylvania

Herewith are given the bids received October 9, by the Pennsylvania State Highway Department for the construction of certain sections of road. The schedule of bids was furnished by J. D. O'Neil, State Highway Commissioner.

Cambria County, East Taylor Township, Route 52, Section 4-C, 9,878 linear feet of vitrified block pavement, 16 ft. wide.

E. H. Brua, Hollidaysburg, Pa.	$ 78,855.43
Mainwaring and Cummins, Inc., Germantown, Philadelphia, Pa.	92,934.30
G. T. Morgan, Johnstown, Pa.	83,900.75
Richard Hopkins, Troy, N. Y.	80,751.60
John L. Elder, Ebensburg, Pa.	79,624.46

Cambria County, Jackson and East Taylor Townships, Route No. 52, Section 4-B, 11,070 lin. ft. of vitrified block pavement, 16 ft. wide.

Mainwaring and Cummins, Inc., Philadelphia, Pa.	$109,889.60
John L. Elder, Ebensburg, Pa.	95,881.60
E. H. Brua, Hollidaysburg, Pa.	96,520.19

Lackawanna County, Moosic and Old Forge Boroughs, State-aid Applications Nos. 487-442,—6,562 lin. ft. reinforced concrete pavement, 16 ft. wide.

O'Brien Brothers, Avoca, Pa.	$ 32,308.73
H. B. Sproul Construction Co., Inc., Peekskill, N. Y.	35,138.80
Hagen Lumber Company, Scranton, Pa.	44,132.40
P. J. Boyle Construction Co., Wilkes-Barre, Pa.	32,995.17
Gibbons & Buckley, Philadelphia, Pa.	25,498.96
Matthias Stipp & Son, Scranton, Pa.	27,641.65
Herrick Construction Co., Wilkes-Barre, Pa.	33,792.00
John J. Phillips, LaPlume, Pa.	58,558.50

Washington County, Cecil and North Strabane Townships, Route 108, Sec. 1. 19,318 lin. ft. of vitrified block and reinforced concrete pavement, 16 ft. wide.

Peter F. Connolly, Elmira, N. Y.	$165,139.80

Allegheny County, South Fayette Township, Route No. 108, Section 1, 16,852 lin. ft. of vitrified block pavement and reinforced concrete pavement, 16 ft. wide.

Robert Swan, Jr., Company, Pittsburg, Pa.	$210,720.96

Washington County, East Bethlehem Township, Route 268, State-aid Application No. 738; 5,900 lin. ft. vitrified block and reinforced concrete pavement, 16 ft. wide.

Crosson Construction Company, Brownsville, Pa.	$ 75,322.00

Lehigh County, Hanover Township, Route 159, Section 1; 11,857 lin. ft. of reinforced concrete pavement, 16 to 20½ ft. wide.

J. C. Bentley, Elizabeth, N. J.	$ 72,857.80
George H. Hardner, Allentown, Pa.	69,375.80
Richard Hopkins, Troy, N. Y.	76,838.00
Mainwaring & Cummins, Inc., Philadelphia, Pa.	78,216.35

Butler County, Clinton Township, State-aid Application No. 417; 5,800 lin. ft. of vitrified block pavement, 16 ft. wide.

Robert J. Swan Jr. Company, Pitsburg, Pa.	$ 64,105.50
Norman J. Boyer, Butler, Pa.	30,255.97
Kennedy Contracting Company, Utica, N. Y.	34,729.96

Westmoreland County, East Huntingdon Township, State-aid Application No. 324; 2,540 lin. ft. of vitrified block pavement, 16 ft. wide.

Rimonti Galiardi, Connellsvile, Pa.	$ 20,955.80

Montgomery County, Upper Moreland, Abington and Upper Dublin Townships, State-aid Application No. 648; 6,537 lin. ft. of reinforced concrete pavement. 16 ft. wide.

Mainwaring and Cummins, Inc., Philadelphia, Pa.	$ 50,651.65
Ambler, Davis Company, Philadelphia, Pa.	44,349.60
The Juanita Company, Philadelphia, Pa.	45,511.05

Venango County, Cornplanter Township, Application No. 681; 7,857 lin. ft. of vitrified pavement, 16 ft. wide.

Elmer M. Love & Son, Corry, Pa.	$ 56,663.45

Bids Received on Paving Liberty St., Newburgh, N. Y.

The following alternate bids, reported by Henry Wilson, City Manager of Newburgh, N. Y., were received early in November for the improvement of Liberty St. between Broadway and Renwick St:

Warren Bros. Company.

Bitulithic	$ 30,150.00

Joseph A. Fogarty.

Bitulithic	$ 31,367.25
2-in. Asphalt Block	31,771.00
2½-in. Asphalt Block	32,901.50
Mack Brick	34,193.50

If gravel is used in place of broken stone in concrete foundation, Mr. Fogarty's bids would each be reduced $161.50.

Harper & Higginson, Inc.

Bitulithic	$ 32,870.75
2-in. Asphalt Block	34,889.50
Metropolitan Brick	37,150.50

Henry F. English.

2-in. Asphalt Block	$ 35,384.50
2½-in. Ashphalt Block	36,595.75
Mack Brick	38,210.75

Bids on Highway Work in California.

Table I gives a summary of the proposals opened Nov. 5, 1917, by the California Highway Commission for constructing

Table I—Bids for Constructing a California State Highway, Received Nov. 5.

Items.	Quantities.	Engineer's Estimate.	Geo. R. Curtis, Los Angeles. Bid.	Geo. R. Curtis, Los Angeles. Amount.	Fred Hoffman,, Long Beach. Bid.	Fred Hoffman,, Long Beach. Amount.	A. L. McCoy, Los Angeles. Bid.	A. L. McCoy, Los Angeles. Amount.
1. Excavation—								
without classification	53,700 cu. yds.	$ .40	$ .90	$ 48,330.00	$ 1.00	$ 53,700.00	$ .75	$ 40,275.00
2. 18-in. cor. metal pipe	858 lin. ft.	.50	1.00	858.00	1.00	858.00	2.00	1,716.00
3. 24-in. cor. metal pipe	365 lin. ft.	.75	1.50	547.50	1.50	547 00	2.00	730.00
4. Portland cement concrete—								
Class "A" (Cul's. & Mon's.)	310 cu. yds.	14.25	15.00	4,650.00	15.00	4,650.00	16.00	4,960.00
5. Portland cement concrete—								
Class "A" (pavement)	9,800 cu. yds.	5.25	8.60	84,280.00	5.50	53,900.00	6.00	58,800.00
6. Guard rail	4,600 lin. ft.	.45	.50	2,300.00	.75	3,450.00	1.00	4,600.00
7. Monuments (haul and set)	170 each	.50	1.00	170.00	1.00	170.00	1.00	170.00
Net total		$80,205.25						
Contingencies, 15%		12,030.79						
Totals		$92,236.04		$141,135.50		$117,275.50		$111,251.00

a state highway. The work is located in Los Angeles County, Division 7, Route 9, Section A.

The materials furnished by the state cost $39,422.50 and comprised: Pipe railing for culvert, reinforcing steel, corrugated metal pipe, Portland cement and asphaltic oil surfacing.

Bids On Paving In Philadelphia

Fred C. Dunlap, Chief of the Bureau of Highways in Philadelphia, reports the following bids received on grading and paving on Sept. 5, 1917:

Schedule "A"—Grading.

Total amount of low bids.....$222.68

586 cu. yds. fill (425 cu. yds. cut). Average price of $0.38 per cu. yd.

Low Bidder. *Address.*

Edw. Ganley.....7116 York Road

Schedule "B"—Asphalt Paving.

Total cost of low bids.....$41,001.06

Asphalt pavement, including 6-in. concrete base. Average price of $2.751 per sq. yd.

Low Bidders. *Addresses.*

Mack Paving & Constr. Co.—Nicetown, La. & Whitaker Ave.

Barber Asphalt Paving Co.....Land Title Building

Philadelphia Paving Co.....1345 Arch St.

Schedule "C"—Vitrified Block Paving.

Total amount of low bids.....$12,059.59

Vitrified block pavement, including 6-in. concrete base. Average price of $3.71 per sq. yd.

Low Bidders. *Addresses.*

Cunningham Paving and Construction Co.....1345 Arch St.

Mack Paving and Constr. Co....Nicetown, La. & Whitaker Ave.

Schedule "D"—Bituminous Concrete Paving.

Total amount of low bids.....$10,751.38

Bituminous concrete pavement (Spec. "A"), including 6-in. concrete vase. Average price of $3.25 per sq. yd.

Low Bidder, *Address.*

Philadelphia Paving Co.....1345 Arch St.

Schedule "E"—Granolithic Footway Paving.

Total amount of low bids.....$2,431.20

Granolithic footway paving, including 6-in. cinder base. Average price of $1.71 per sq. yd.

Low Bidder. *Address.*

Reed & O'Rourke.....1213 Cherry St.

Schedule "F"—Asphalt Repaving.

Total amount of low bids.....$24,818.13

Asphalt repaving, including 6-in. concrete base. Average price of $2.416 per sq. yd.

Disposing of old pavement and sub-grading. Average price of $0.67 per sq. yd.

Low Bidders. *Addresses.*

Barber Asphalt Paving Co.....Land Title Building

Mack Paving & Constr. Co.....Nicetown, La. & Whitaker Ave.

Schedule "G"—Vitrified Block Repaving.

Total amount of low bids.....$2,544.70

Vitrified block repaving, including 6-in. concrete base. Average price of $3.513 per sq. yd.

Disposing of old pavement and sub-grading. Average price of $0.40 per sq. yd.

Low Bidder. *Address.*

Cunningham Paving & Constr. Co.....1345 Arch St.

Schedule "H"—Wood Block Repaving.

Total amount of low bids.....$4,607.98

Wood block repaving, including 6-in. concrete base. Average price of $4.013 per sq. yd.

Disposing of old pavement and sub-grading. Average price of $0.48 per sq. yd.

Low Bidder. *Address.*

E. C. Fish & Co.....Real Estate Trust Bldg.

FIRE ENGINEERING

Fire Tests of Building Columns

The Associated Factory Mutual Fire Insurance Companies, the National Board of Fire Underwriters and the Bureau of Standards of the Department of Commerce are jointly conducting fire tests of building columns at Underwriters' Laboratories, 207 East Ohio street, Chicago. The first test was run June 28, and it is planned to run about two tests per week throughout a period of twelve months. The time for the tests

is scheduled and may be ascertained in advance by those having a proper interest in the subject.

Types of Columns and of Column Protection.

The types of columns being tested include rolled steel sections, built up steel sections, round cast iron sections, steel pipe filled with concrete and vertically reinforced and hooped concrete columns, to which it is proposed to add several wooden columns. At least one of each of the sections is unprotected, others are partially protected by concrete and others completely protected by various thicknesses of concrete, clay tile, filled and unfilled, gypsum blocks, plaster on metal lath and common brick, in accordance with the methods commonly employed in practice.

The tests on unprotected columns are made to furnish information as to the ability of the columns to withstand fire, and to obtain information relative to the influence of the type of column section, which latter forms a basis for comparison of the various methods of column protection.

Columns partly protected by filling the re-entrant portions with concrete are introduced as a type made necessary where space limitations prevent the use of full protection. Besides giving information on the merits of this type of protection as compared with unprotected steel, cast iron and wooden columns, it is also thought that they will give further data on the influence of type of steel section on fire resistance.

Of the 24 tests devoted to full concrete protection, the 8 made on the rolled H section employ, with 3 exceptions, all of the concrete aggregates used in the full series of tests. This is done to give comparison between the rolled H section and the other sections with the same thickness of covering made of the same aggregate, and also to compare the efficiencies of the various concretes in point of heat insulation and fire resistance.

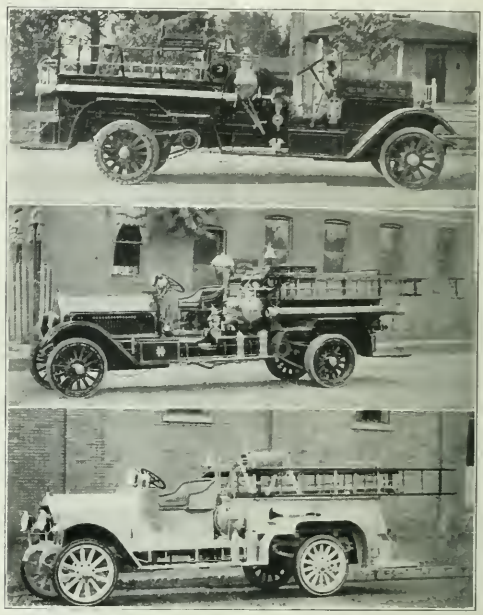
The reinforced concrete tests, consisting of 3 vertically reinforced square columns, 3 vertically reinforced round columns, and 3 spirally hooped and vertically reinforced columns, are designed to show the effect of shape of column, and also the effect of type of reinforcement on fire resistance.

The column coverings have been applied by experienced men in accordance with plans and specifications drawn to secure average results obtained under ordinary commercial conditions.

Some New Motor Fire Apparatus

The City of Muncie, Ind., has recently placed in service two of the South Bend Double Duty Hoosier Pumps. The Hoosier pumps are a triple combination fire engine. The motor is a 95 H. P. power 5¾x7-in., 4-cylinder motor with Leece-Neville starter and lighting system. They are 500-gal. per minute capacity, 40-gal. chemical tanks and are on Goodyear cushion tires. One of the Muncie units is here illustrated.

The illustration shows also a unit recently delivered in Kendallville, Ind., which is a 500-gal., 6-cylinder machine. This unit is a 5¾x7-in., 6-cylinder motor.



UPPER—TRIPLE COMBINATION FIRE ENGINE, MUNCIE, IND. MIDDLE—NEW MOTOR FIRE APPARATUS, KENDALLVILLE, IND. LOWER—COMBINATION CHEMICAL AND HOSE WAGON, NEWBURGH, N. Y.

Another view is shown of a South Bend type CH-60 combination chemical and hose wagon, with a 4¾x5½-in., 4-cycle motor with a Westinghouse starter and lighting system, 40-gal. chemical tank and also all the necessary equipment, as shown.

This unit is for the Ringgold Hose Co., Newburgh, N. Y. It is finished in pearl gray and is decorated in silver.

SALES ENGINEERING

What a Concrete Building Selling Campaign Should Embrace and What Should Be Avoided

By J. P. H. Perry, Contract Manager, Turner Construction Co., New York City

Selling a concrete building to its owner, now that reinforced concrete is so widely accepted as a meritorious material for industrial buildings, usually really means the getting of the contract to erect such a building. It seems to me that fundamentally it makes little difference whether we are out to get a lump-sum contract, a cost-plus-percentage contract or a cost-and-profit-sharing contract, or any of the many service forms of building contracts—the underlying principle is to get the job. The perfect salesman for this class of business is the fellow who can get the contract, said Mr. Perry, in addressing the Salesmanship Congress.

Form of Contract of Secondary Importance

It has been my experience that contractors weaken their selling campaigns the moment they attempt to dictate to the prospective customer how that customer shall do his business. Our position has always been that we were out to sell our services to our customers on any fair basis and that the form of contract they chose was of secondary importance.

Suppose you hear of a factory that is going to be built and you decide you want the contract:

You've got considerable of a task to make the proper approach and interest your prospect in your proposition. Perhaps you have, first of all, to sell concrete as compared to steel or mill construction, if the status of the building, so far as material or construction is concerned, is not already established. That accomplished, either by you or previously, next comes the actual contract getting, talking points, such as your company's record of work done, its present readiness to erect the building in question, its financial strength and the perfection of its organization. Then the merits have to be made clear of such factors as the plant ready to send to the job at once, the liveness of the traffic department, the speed records and what certainty of delivery means, and, above all else, dependability of performance.

To drive home to the buyer's inner consciousness, to that part of him which actually moves himself as distinct from the external casual momentary side of him, these selling arguments; and also to make each of the many other talking points count and win; to tell this story so that the listener will believe it, and, what is more, believe it so he knows unalterably that what is back of the salesman is the best on the market—all this is ordinarily as much as the salesman can hope to accomplish.

If you bring up the question of the particular form of contract that the contractor will alone accept, you add to the salesman's task and bring in a new element, which really is a subject by itself and but a detail of the big selling problem.

What Intensive Selling Methods Have Accomplished

The statement has been made that no selling is possible except when the contract takes the form of a service or percentage document. I want to take exception to this statement. I know of many instances where hard, intensive selling—such, for example, as interviews, telephone calls, frequent telegrams, photographs, monthly, weekly, daily, twice a day, influence channels properly worked, printed literature, inspection trips to similar jobs—where such good hard sweating has landed the contract at a preference in the straightest and hardest kind of competitions.

Two instances, particularly, are in my mind—one a competition of lump-sum bidding of ten bidders for three-quarters of a million dollar job, where the fifth from the bottom bidder secured the job at $60,000 preference. Hard selling, backed by unblemished reputation and unusual speed records, influenced the board of directors to pay the premium. Another case of a nearly million dollar job. Thirteen bidders, the pick of the country, straight-lump bids, nearly $80,000 preference to the ninth highest bidder. Selling did it.

The intelligent owner starts out not to buy a particular kind of contract, but to select the contractor he believes will serve him best. Of course, if the contractor can persuade the owner to award the job without competition so much the better, and for this kind of a deal the service or percentage contract has many merits and advantages and is rapidly coming into force. In fact, the writer's company, out of 32 concrete buildings contracted for in the first five months of 1917, handled 26 on a cost and percentage basis. But, as far as the general selling problem is concerned the form of contract is secondary. Sell your services first and then sit down with the lawyers to sign the papers. The contract form is but one of the great building salesman's many talking points—to be used as needed.

The Two Classes of Industrial Executives

Industrial executives in letting building contracts may, in my experience, be divided into two broad classes, and I believe this division applies pretty widely to any set of buyers: First, the man (or company) who wants what he wants more than the money it costs; second, the fellow who thinks more about the price than he does about his purchase.

Number One you can sell. He wants a good building built on time and is willing to pay a fair price. Secure his confidence and let him write his own contract (whether he takes competition or not depends on the salesman or on unchangeable conditions). There is, as other builders have well pointed out, no better line of attack than to reach your man through his own industry or his own friends. Another good way to sell buildings is to let some one else sell for you. Impartial opinion, real or ostensible, goes miles beyond prejudiced salesman's talk. Architects or engineers should be cultivated to this end.

Often competitive bids are taken by this first class of buyers, but they select from their bids the concern they believe to be the best. Of course, price has to be considered, but is of secondary importance. A good building salesman keeps it there. The refusal of a job at a price other than your bid is a situation to be sought and of great value when secured.

Price Being Talked Out of Contracting Business

Number Two can also be sold, but it is a far harder accomplishment and rather rare, unless we consider getting a job on price selling. Personally, I think it is order taking. Price alone is being more and more talked out of the modern contracting business, but it's a mighty big factor yet.

The architect and the engineer are susceptible to the same line of thought as the owner. Of course, the details of approach, argument and closing are radically different, but the foregoing principles are fundamentally correct here as well.

In selling reinforced concrete buildings a man is arguing the merits of a material or of a class of construction.

Requirements Vital to Successful Selling

In getting a job the contractor is, of course, selling services—often the two problems dovetail. It seems to me, however, that for either or both the following requirements are vital to successful selling.

First. Perfect your organization to the point where it can and does do what is claimed for it. Overstatements of merit give but temporary success.

Second. Advertise energetically and as extensively as your purse affords. Job signs, booklets, photographs, magazines, newspapers—all are effective.

Third. Intensively sell by means of men of pleasant personality who know their game; that is, are experienced in the concrete construction field, can design broadly and advise knowingly and, above all, who have energy and courage and won't take no.

Salesmen You Ought to Know.

When it comes to representing a large number of well-known lines few agents for contractors' equipment have anything on our friend, George F. Smith, of Franklin and Channing avenues, St. Louis, Mo. Since 1910 he has represented the Clyde Iron Works of Duluth, Minn., the Sasgen Derrick Co. of Chicago and the Smith Engineering Works of Milwaukee. For two years he has represented the Insley Manufacturing Company of Indianapolis, for one year the Blaw-Knox Co. of Pittsburgh, for two years the Novo Engine Co. of Lansing, Mich., and for four years his neighbor, the Whitman Agricultural Co. of St. Louis. He covers the southern half of Illinois and the eastern half of Missouri. He offers his customers a force of trained mechanics, a large stock of equipment available at rush notice, repairs for their machines and an organization to reduce delays and expense to a minimum.

Carey Floyd Lawrence, of Greensboro, N. C., is optimistic by nature and predicts that the war will be over by September 1, 1918. His cheerful view of things results, no doubt, from his success in representing the Lewis-Hall Iron Works of Detroit, the Denman Motor Co. of Cleveland and the Detroit Trailer Co. of Detroit, Mich. He covers North Carolina and makes a hobby as well as a business of selling motor trucks. And they say he owns as many Liberty Loan bonds as any man in the state.

Washington Irvin Thompson, of Jackson, Mich., knows, personally, every contractor, street and road builder in Michigan, and also in Toledo, Ohio, and in northern Indiana. He goes through the Lower Peninsula with a fine tooth comb and makes side trips to Toledo and Fort Wayne. He has specialized in the sale of Kelly Springfield road rollers since the first

W. I. THOMPSON.

of 1909 and sells twenty-five of them in a year, on the average. Another hobby of his is good roads. He has frequently addressed public meetings on this topic. He gets along famously with the contractors and, despite his open countenance, is a nifty poker player. He is thinking of adding several lines to his string.

It is good to reflect on the comfortable circumstances and salubrious surroundings of P. E. Longstreet, dealer in contractors, industrial and municipal supplies, who holds forth at 236 Marsh-Strong Bldg., Los Angeles, Cal. To begin with, he is favored by being the representative of such concerns as the Lakewood Engineering Co., the Minneapolis Steel and Machinery Co., the Thew Automatic Steam Shovel Co., the Heltzel Steel Form and Iron Works, Byer's Autocrane, Orton & Steinbrenner, F. D. Cummer & Sons Co., Tiffin Wagon Works, Webster Manufacturing Co. and Plymouth Locomotives. He also handles motors, generators and electrical apparatus and used equipment of all kinds. He is strategically stationed to intercept those who are coming and those who are going. And, as if representing so many such A-1 firms was not enough, he has the additional good fortune to live in Los Angeles and actually knows a lot of the screen ladies, with whom, he admits, he is a great favorite. As we have had occasion to remark before, some people sure do seem to have more than their share of the good luck.

F. R. Schoen, of the Burbank Machinery Company, of Seattle, Wash., persists in referring to this section of M. E. as the "Rogues' Gallery." Now he comes through with a picture of himself, his motor car and his two boys, named in the inverse order of their importance in his household. It is his misfortune to work in a business in which he is personally interested, so he has seldom had the pleasure of taking such a

F. R. SCHOEN.

vacation as is enjoyed annually by corporation employees. This year it was a bit different, and he loaded friend wife and the boys into the Ford and made for the north fork of the Snowqualmie River, where the accompanying view was taken. He has recently stocked his warehouse with all sorts of road machinery manufactured by the Western Wheeled Scraper Company, of Aurora, Ill. He is interested in practically all kinds of contractors' equipment.

PERSONAL ITEMS

J. Hinman has been appointed City Manager of Hanford, Calif.

C. A. McComber has been appointed City Manager of San Anselmo, Calif. He was formerly manager of the Marin Rock Co.

L. R. Cook has been appointed City Engineer of Nampan, Idaho, to succeed Ogden Dutcher, who resigned.

Herman C. Allen, Wallace, Idaho, has been appointed State Highway Engineer, to succeed E. M. Booth, who recently resigned.

Gerald T. Wagner has been appointed City Engineer of Grand Rapids, Mich., to succeed W. S. Moore, who for some months has been chief engineer of the Indiana State Highway Department.

John V. Brown is now manager of the Water Company at York, Nebr.

Paul W. Treanor was recently appointed commissioner of Water Works at Nashville, Tenn.

Robert Blakemore, for years commissioner of the Fargo, N. Dak., Water Works has been appointed Fuel Administrator for Cass County, Nebraska.

L. W. Allen has been appointed manager of the Alabama Water Co. plant at Anniston, Ala. He was formerly connected with the Birmingham Railway Light & Power Co.

G. E. Hoffmaster was recently elected president of the Birmingham, Ala., Water Works Co. to succeed A. M. Linn, who

is now president of the West Pennsylvania Railways Co. with headquarters at Pittsburg. Mr. Hoffmaster has long been in the service of the American Water and Electric Co. of New York. He has been at the head of various of the local water companies.

GEORGE H. TEFFT, for many years well known in the Clay Products Industry, is now secretary and general manager of the recently reorganized Clay Products Association. His offices are in the Chamber of Commerce Building, Chicago. Mr. Tefft is best known for his many years of service with W. S. Dickey, the Kansas City vitrified clay pipe manufacturer, and for his work as secretary of the International Clay Products Co., and as director of the Clay Products Exposition which has been held in connection with the annual meeting of the National Brick Manufacturers' Association.

T. B. SHERTZER has been made Eastern district engineer of the Hydrated Lime Bureau, Pittsburg, with offices in New York City. He was formerly an assistant engineer of the Bureau of Highway at Philadelphia, and more recently was city manager at Portsmouth, Va.

W. T. POTTER, of El Paso, and R. J. WINDROW, of Waco, Texas, have been appointed members of the State Board of Water Engineers by Governor Hobby. Mr. Potter succeeds Major John Wilson, of Barstow, who had been a member of the board since its formation, while Mr. Windrow fills the vacancy caused by the recent resignation of J. C. Nagle, who was chairman of the board. Mr. Windrow has for the past four years been County Engineer of McLennan County. Mr. Potter has been secretary of the board.

F. W. SCHREIBER, for the past seven years city engineer of Watertown, S. D., has been appointed assistant highway engineer of the South Dakota Highway Commission.

ARTHUR F. SHUEY, formerly assistant engineer of the Florida State Board of Health, has been appointed Superintendent of the Tampa, Fla., Water Works Company.

ERNEST MCCULLOH has joined the staff of Charles L. Pillsbury Co., engineers, of Minnesota and St. Paul, and will have charge of the civil engineering department. Mr. McCulloh is the author of well-known engineering books and has been a frequent contributor to engineering periodicals. He has also had extensive experience in city engineering work, notably in the City of Los Angeles. He also served for a time in the engineering staff of the United States Reclamation Service.

HOMER HAMLIN, until recently and for many years City Engineer of Los Angeles, Cal., has opened an office as consulting engineer and geologist with headquarters in the Central Building, Los Angeles. He will specialize in engineering and geological work connected with surface and underground drainage, water supply, sewerage, sewage disposal, irrigation, and will specialize in all municipal engineering problems.

CLIFFORD OLDER, for some years bridge engineer in the Illinois State Highway Department, has been appointed acting chief highway engineer of that state, to fill temporarily the position made vacant by the death of the State Highway Engineer, William W. Marr.

GEORGE L. CHRISTIAN has been appointed Deputy City Engineer of Yonkers, N. Y. He was formerly assistant engineer in the Department of Public Works in the Borough of Manhattan.

J. N. WELLS, of Kokomo, Ind., has been appointed superintendent of the Muncie, Ind., Water Co., to succeed the late Quincy Walling.

C. H. BUNDY, who for a time was acting superintendent following Mr. Walling's death, has been promoted to the superintendency of the Kokomo Water Co., to succeed Mr. Wells. Mr. Wells has been superintendent at Kokomo for 16 months and prior to that time was head of the Wichita, Kans., Water Co.

J. DENNY O'NEIL, of McKeesport, Pa., who was appointed State Highway Commissioner by his excellency, Governor Martin G. Brumbaugh, on September 6, 1917, was born in Elizabeth, Allegheny County, Pa., in 1866. He received his education in the public schools at Elizabeth and started work in early life. In 1885 he removed to McKeesport, where he engaged in the department store business. His rise in business, financial and political circles was rapid. He is president of the Union National Bank, the Daily News Publishing Co. and the J. D. O'Neil Co., all of McKeesport. He was also president of the State Merchants' Association and an officer of the Associated Dailies' Association of Pennsylvania. From 1902 to 1905 he served as Recorder of Dedes of Allegheny County and from 1908 to 1915 as County Commissioner. On June 23, 1916, Governor Brumbaugh appointed Mr. O'Neil Insurance Commissioner of Pennsylvania. During the short time he occupied this office notable work was accomplished by which many fraudulent companies were exposed and driven out of business. Mr. O'Neil's policy in connection with the work of the State Highway Department will be a vigorous one. Taking hold of the reins of this big department at a time when abnormal conditions exist, he has many serious obstacles to overcome. However, in the little over six weeks of his administration some important contracts have been let and it is expressed intention to link up the important highways of the commonwealth just as rapidly as possible. He is also working to better conditions on state roads within borough limits. Maintenance of trans-state highways during the winter months so that they will be passable at all times for the heavily increased motor truck traffic is receiving the commissioner's attention.

F. M. EDWARDS is the new City Engineer of Jacksonville, Fla.

CHARLES SCHULTZ has been made superintendent of Water Works at Kinney, Texas. He will continue to serve also as city engineer.

F. O. MCGILL, JOHN EDDY, B. E. CUNNINGHAM and L. E. MCKEETH will engage in the general contracting business under the firm name of Gem State Construction Co., with headquarters at Nampa, Idaho.

Following is a full roster of the officers of the 108th U. S. Engineers, formerly the First Regiment Engineers, Illinois National Guard, and the civilian positions they held prior to enlisting:

Staff.

Colonel Henry A. Allen—Mechanical, electrical and civil engineer.

Major Perry W. Swern—Member Berlin & Swern, Architects, Chicago, Ill.

Major Charles Roth—Factory Manager, Kitchen Service Co., Chicago Ill.

Captain Adjutant John J. O'Connor—Logging and railroad engineer.

Captain F. H. Cobb—Manager and superintendent Drafting Department, Meyer Both Co., Chicago, Ill.

Captain D. D. Guilfoil—Sales engineer, Sauerman Bros., Chicago, Ill.

Captain H. L. Laughlin—Engineer Erwing & Allen, Consulting Engineers, Chicago, Ill.

Captain Harry F. Hamlin—Director Massachusetts Tire and Rubber Co.

Lieutenant O. M. Caward (Chaplain)—Moderator Presbytery, Chicago, Ill.

Sanitary Corps.

Major R. J. McDonnell—Doctor.

Lieutenant Mark M. Duffy—Doctor.

Lieutenant Joseph W. Sanborn—Dentist.

Company A.

Captain C. C. Saner—Designing engineer Bureau of Engineering, City of Chicago.

Second Lieutenant Wm. H. Dean—Assistant engineer, Bureau of Engineering, City of Chicago.

Company B.

Captain B. C. Allin—Civil engineer Bridge Dept., C. R. I. & P.

First Lieutenant L. J. Hughes—Civil engineer, Bridge Department, C., R. I. & P.

Second Lieutenant F. R. Wiwi—Electrical engineer.

Company C.

First Lieutenant W. L. Hudson—Gas engine expert, Vehicle Bureau, City of Chicago.

First Lieutenant H. A. Roe—Assistant in Mechanical Engineer's office, Pullman Co., Chicago.

Second Lieutenant C. A. M. Waterhouse—Mechanical engineer.

Company D.

Captain A. H. Sheffield—Sales manager and construction engineer, Terre Cotta Construction, Chicago. Ill.

First Lieutenant L. R. Gurley—Estimating engineer, American Terra Cotta and Ceramic Co., Chicago, Ill.

First Lieutenant F. R. Stauffer—Engineer L. K. Comstock Co., New York.

Second Lieutenant W. R. Wood—Engineering editor and publisher.

Company E.

Captain J. A. Rossiter—Engineer track elevation and railroad expert for City of Chicago.

First Lieutenant J. H. Jacobson—Estimating engineer Commonwealth Edison Co., Chicago, Ill.

First Lieutenant Walter Farwell—Vice-president J. V. Farwell Co., Chicago, Ill.

Second Lieutenant Wm. H. Bready—Mechanical engineer Permutit Co. of New York.

Company F.

Captain R. C. Harris—Construction superintendent and architect.

First Lieutenant E. Lippe—Consulting engineer.

First Lieutenant C. L. Brundage—Structural Steel Dept., J. T. Ryerson & Son.

TRADE NOTES

R. D. Karnes & Son, Princeton, W. Va., have just received shipment of a 3-ton Stegman 6-cylinder dump truck, equipped complete with electric starter, electric lighting system, driver's cab, windshield and hydraulic hoist, intended for the County of Mercer, W. Va., to be used in road work.

H. M. Lee, president of the Duplex Truck Co. of Lansing, Mich., announces that Herman Loeffler has become a member of the Duplex sales department and will represent the company in the eastern states. Mr. Loeffler was connected with the Fairbanks-Morse Co. for 10 years, and for the last three years has been associated with the Novo Engine Co.

The appointment of George E. McLaughlin as Traffic Manager of the Dort Motor Car Co. of Flint, Mich., is further evidence of a tendency on the part of manufacturers to seek trained railroad men for positions of this nature. Mr. McLaughlin has been an employe of the Pere Marquette Railroad for 16 years, recently as trainmaster at Toledo. He brings to his new position a wide acquantance and popularity among railroad men, as well as proved executive ability.

The Standard Asphalt and Refining Company of Chicago, Ill., has purchased the plants, trade marks and good will of the Sarco Petroleum Products Companies. The Cities Service Company of 60 Wall street, New York city, is the new interest back of this company, although the management essentially remains the same as before the change. Mr. Charles Muller, who was an executive of the former company, now becomes manager. He has been associated with the old company for ten years and has risen through the ranks to his present position and is well known in business and financial circles in Chicago. Mr. Robert F. Trumbull has been promoted to manager of the railway and building materials department. He has been in the service of the old company for eight years in this department. By constant contact with the trade during that time he is intimately acquainted with its requirements for asphalt materials.

W. C. Rowley has been elected vice-president of the Federal Motor Truck Company of Detroit, and is also in charge of sales. He has long been a director and stockholder in the Federal Company. F. L. Pierce is now the Federal sales manager, Frank P. Soper, assistant sales manager, and E. W. Winans, service manager.

The Blaw-Knox Company of Pittsburgh, Pa., announce that they have closed their Boston office for the period of the war because of the heavy draft on their sales and engineering forces by the military establishment. All business of the Boston territory will be handled through the New York office at 165 Broadway.

H. S. Daniels, whose services have been for some time employed jointly by the Dort Motor Car Company and the Dooley-Brennan Company, will hereafter devote his entire time and attention to the advertising management of the Dort organization under the title of advertising manager. This new arrangement has necessitated the removal of Mr. Daniels from Detroit to Flint, where the Dort factory is located.

V. K. McBride, for the last three years assistant sales manager of the Federal Motor Truck Company, has resigned to become sales manager of the American Motor Truck Company of Detroit, Mich. Mr. McBride has a very wide acquaintance in the motor truck trade. When the Universal Truck Company initiated the deferred payment plan several years ago, Mr. McBride was the sales manager of that organization. Later he was sales manager of the Alden-Sampson Company, makers of trucks, a firm that was taken over by the Maxwell Motor Company, and later discontinued.

H. E. Hilts, formerly district engineer at San Francisco for the Portland Cement Association, has been elected by the board of directors of that body to succeed the late Mr. J. P. Beck as general manager.

The Stegeman Motor Car Company has just shipped one of its large 6-cylinder 4-ton dump trucks to Knox county, Ohio, for road construction work. The machine is equipped complete with electric-starter, electric-lighting system and hydraulic hoist, also cab and windshield. It was sold through the Good Roads Supply Company, 390 North High street, Columbus, Ohio, agents for contractors' equipment.

The Texas Company, New York City, has issued a 32-page illustrated booklet on Texaco Crater Compound. There is evidence in the booklet to show that marked economies can result from the use of Crater Compound instead of any lubricant that comes handy, from black oil to pitch and graphite. It is especially true of wire rope lubrication that substances are frequently used that are entirely unfit for this purpose. In collecting data on the subject this booklet should be secured by all means. The cost per foot of wire rope has reached an alarming point. The only way to overcome it is to get greater life.